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AUTHOR	Lee, Billy D.; And Others
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ABSTRACT

This publication contains instructional materials for both teachers and students for a course in automotive emission control. Instructional materials in this publication are written in terms of student performance using measurable objectives. The course includes 16 units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, transparency masters, tests, and answers to the tests. Units are liberally illustrated and are planned for more than one lesson or class period of instruction. Information for the teacher includes an instructional analysis of automotive emission control, and a list of tools and equipment needed. Topics covered in the 16 units are the following: introduction to automotive emission control; internal combustion engine pollutants; origin of internal combustion engine pollutants; heated air induction systems; evaporative emissions control system; engine modification; carburetor modifications; ignition timing system; spark advance controls; exhaust crossover system; exhaust gas recirculation system; positive crankcase ventilation system; air injection system; catalytic converter systems; electronic controls; and testing. (KC)

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ED219645

AUTOMOTIVE EMISSION CONTROL

by
Billy D. Lee
and
Ronald Razazzi

Revised by
Don Eshelby

Developed by the
Mid-America Vocational Curriculum Consortium, Inc.

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PREFACE

For many years those responsible for teaching automotive emission control have felt a need for instructional materials to use in this area. A team of teachers, industry representatives, and trade and industrial education staff members accepted this challenge and have produced manuals which will meet the needs of many types of courses where students are expected to become proficient in the area of automotive emission control. The MAVCC Automotive Emission Control publication is designed to supplement the existing auto mechanics instructional materials currently used by school system personnel.

Every effort has been made to make this publication basic, readable, and by all means usable. Three vital parts of instruction have been intentionally omitted from this publication: motivation, personalization, and localization. These areas are left to the individual instructors and the instructors should capitalize on them. Only then will this publication really become a vital part of the teaching-learning process.

In addition, we would appreciate your help. We check for content quality, spelling, and typographical errors many times in the development of a manual. It is still possible, however, for an error to show up in a publication.

If, in the use of this publication, you should find something questionable we would appreciate you bringing it to our attention. A copy of the page or pages in question with your suggestions for correction would certainly help us when we revise and update materials.

We're trying to provide you with the best possible curriculum materials and will certainly appreciate your help in detecting areas where possible corrections are needed to maintain the quality you want and deserve.

Ann Benson
Executive Director
Mid-America Vocational Curriculum
Consortium, Inc.

FOREWORD

The Mid-America Vocational Curriculum Consortium (MAVCC) was organized for the purpose of developing instructional material for the twelve member states. Priorities for developing MAVCC material are determined annually based on the needs as identified by all member states. One of the priorities identified was automotive emission control. This publication is designed to provide the needed instructional material to supplement auto mechanic programs.

The success of this publication is due, in large part, to the capabilities of the personnel who worked with its development. The technical writer has several years of industry as well as teaching experience. Assisting him in his efforts were representatives of the auto mechanic profession who brought with them technical expertise and the experience related to the classroom and to the trade. To assure that the materials would parallel the industry environment and be accepted as a transportable basic teaching tool, organizations and industry representatives were involved in the developmental phases of the manual. Appreciation is extended to them for their valuable contributions to the manual.

This publication is designed to assist teachers is improving instruction. As these publications are used, it is hoped that the student performance will improve and that students will be better able to assume a role in their chosen occupation, automobile repair.

Instructional materials in this publication are written in terms of student performance using measurable objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion referenced evaluation instruments are provided for uniform measurement of student progress. In addition to evaluating recall information, teachers are encouraged to evaluate the other areas including process and product as indicated at the end of each instructional unit.

It is the sincere belief of the MAVCC personnel and those members who served on the advisory committee that this publication will allow the students to become better prepared and more effective members of the work force.

Pat Lindley, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

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Appreciation is extended to those individuals who contributed their time and talents to the revision of the Automotive Emission Control manual.

The contents of this publication were reviewed by:

Ivan Armstrong	Stillwater, Oklahoma
Virgil Swartz	Security, Colorado
Everette Allen	Okmulgee, Oklahoma
Gerald Christenberry	Norman, Oklahoma
Merwin Lewis	Stillwater, Oklahoma

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Gratitude is expressed to Regina Decker for editing and to the Graphics Division personnel, Teddi Cox and Terra Stone, for typing the publication. Appreciation is also given to Mike Adair, Jon Dickey, Edith Mekis, Carrie Williams, Barbara Boyce, Clay Turner, and Dayna King for the illustrations and drawings used in this publication.

The printing staff of the State Department of Vocational and Technical Education are deserving of much credit for printing the publication.

Special appreciation is given to Ford Motor Company, Detroit Art Services, Chrysler Corporation, and General Motors Corporation for granting permission to use technical illustrations in the publication.

USE OF THIS PUBLICATION

Instructional Units

The *Automotive Emission Control* curriculum includes sixteen units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for teacher and students, information sheets, assignment sheets, job sheets, visual aids, tests, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help to determine:

A. The amount of material that can be covered in each class period
B. The skills which must be demonstrated
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets or filmstrips that must be ordered
D. Resource people that must be contacted

Objectives

Each unit of instruction is based on performance objectives. These objectives state the goals of the course, thus providing a sense of direction and accomplishment for the student.

Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction, and specific objectives, stating the student performance necessary to reach the unit objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which may have been used in this material:

Name	Identify	Describe
Label	Select	Define
List in writing	Mark	Discuss in writing
List orally	Point out	Discuss orally
Letter	Pick out	Interpret
Record	Choose	Tell how
Repeat	Locate	Tell what
Give		Explain

Order	Distinguish	Construct
Arrange	Discriminate	Draw
Sequence		Make
List in order		Build
Classify		Design
Divide		Formulate
Isolate		Transcribe
Sort		Reduce
		Increase
		Figure

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Instructors should feel free to add objectives which will fit the material to the needs of the students and community. When a teacher adds objectives, he/she should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a suggested activities sheet outlining steps to follow in accomplishing specific objectives. Duties of the instructor will vary according to the particular unit. However, for best use of the material they should include the following: provide students with objective sheet, information sheet, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss unit and specific objectives, information sheet, and assignment sheets; demonstrate and discuss procedures outlined on job sheets; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Information Sheet

The information sheet provides content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that the information sheet serves as an excellent guide for presenting the background knowledge necessary to develop the skill specified in the unit objective.

Students should read the information sheet before the information is discussed in class. Students may take additional notes on the information sheet.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheet. They are particularly effective when identification is necessary.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for a student to follow if he/she has missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances she/he might reasonably expect from a person who has had this training.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the unit objective. Test items for objectives added by the teacher should be constructed and added to the test.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

Automotive Emission Control

Instructional Analysis

Job Training: What the Worker Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
	Unit I: Introduction to Automotive Emission Control
	1. Terms
	2. Smog and photochemical smog
	3. Sources of air pollution
	4. Federal regulations
	5. Clean Air Act
	6. Areas of automotive emission control
	Unit II: Internal Combustion Engine Pollutants
	1. Terms
	2. Hydrocarbons
	3. Oxides of nitrogen
	4. Health hazards
	Unit III: Origin of Internal Combustion Engine Pollutants
	1. Terms
	2. Sources of unburned emissions
	3. Causes of incomplete combustion
	4. Origin of emissions
	5. Engine variables
	Unit IV: Heated Air Induction Systems
	1. Terms
	2. Purpose
	3. Types of systems
	4. Operation

Job Training: What the Worker Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
5. Determine proper operation of the vacuum motor system	
6. Check vacuum diaphragm unit for leaks	
7. Check proper operation of thermostatically controlled system	
8. Check proper operation of vacuum controlled system	
9. Check proper operation of vacuum override unit	
Unit V: Evaporative Emissions Control System	
	1. Purpose
	2. Components and functions
	3. Methods of carburetor vapor control
	4. Operation of system
5. Change charcoal canister filter	
6. Test fuel tank filler cap	
Unit VI: Engine Modification	
	1. Purpose
	2. Effects on emissions
Unit VII: Carburetor Modifications	
	1. Purpose
	2. Components which have been modified
	3. Effect of modification

Job Training: What the Worker Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
	Unit VIII: Ignition Timing System
	1. Components and functions
	2. Purpose
	3. Thermostatic vacuum switch
	4. Dual diaphragm vacuum advance unit
	5. Operation of cold start spark advance system
6. Test thermostatic vacuum switch	
7. Test vacuum advance unit	
	Unit IX: Spark Advance Controls
	1. Purpose
	2. Components and functions
	3. Abbreviations
	4. Transmission regulated spark system
	5. Speed controlled spark system
	6. Components of different systems
7. Determine operation of transmission controlled spark system	
	Unit X: Exhaust Crossover System
	1. Components and functions
	2. Purpose
	3. Effects
	4. Operation of system
5. Check operation of exhaust crossover system	

Job Training: What the Worker Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
	Unit XI: Exhaust Gas Recirculation System
	1. Components and functions
	2. Purpose
	3. Operation of system
4. Check operation of exhaust gas recirculation system	
	Unit XII: Positive Crankcase Ventilation System
	1. Purpose
	2. Operation of system
3. Make test of PCV system	
4. Test PCV system with tachometer	
	Unit XIII: Air Injection System
	1. Parts and functions
	2. Purpose
	3. Operation of system
	4. Diverter valve
	5. Functions and effects of valves
	6. Components of computer controlled systems
	7. Components of pulse air injection system
	8. Operation of pulse air injection system
9. Inspect air manifold and hoses	
10. Inspect drive belt and set correct tension	
11. Check air pump output	
12. Check diverter valve operation	

Job Training: What the Worker Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
	Unit XVI: Testing
	1. Purpose for testing
	2. Emission control devices and functions
	3. Rules for testing
4. Perform a basic check of emission control devices	
5. Test dual diaphram vacuum advance unit	
6. Adjust idle of an engine	

Job Training: What the Should Be Able to Do (Psychomotor)	Related Information: What the Worker Should Know (Cognitive)
13. Inspect check valve operation	
14. Check vacuum differential valve operation	
15. Check proper operation of auxiliary control mechanism	
Unit XIV: Catalytic Converter Systems	
	1. Terms
	2. Components and functions
	3. Purpose
	4. Types
	5. Components of TWC
	6. Function of CCC
	7. Function of TWC
	8. Operation of catalytic converter protection system
	9. Purposes of nonleaded gasoline
10. Replace catalyst in converter	
11. Check operation of catalytic converter protection system	
Unit XV: Electronic Controls	
	1. Components and functions
	2. Identification of components
	3. Processes of electronic control module
	4. Basic operation of electronic controlled engine system

TOOL AND EQUIPMENT LIST

The following tools and equipment are necessary to complete the procedures as outlined on the job sheets in this publication.

- Basic shop tools
- Vacuum pump
- Vacuum gauge
- Bleed valve
- Shutoff valve
- Freon canister
- External heat source
- Thermostat
- Tachometer
- Line plugs
- Timing light
- Protective gloves
- Pry bar
- Belt tension gauge
- Electrical leads
- General Motors Tool #J-25077 set
- Anti-seize compound
- Replacement catalyst
- Belt tension tool
- Hose plugs
- Propane cylinder and attachment tools

INTRODUCTION TO AUTOMOTIVE EMISSION CONTROL
UNIT I

UNIT OBJECTIVE

After completion of this unit, the student should be able to define automotive emission control and describe government involvement in the regulation of motor vehicle emissions. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define automotive emission control.
2. Distinguish between smog and photochemical smog.
3. List two sources of air pollution related to motor vehicles.
4. Describe briefly how the federal government has become involved in the regulation of motor vehicle emissions.
5. List the two parts of the Clean Air Act which relate to automobile emissions.
6. Match areas of automotive emission control to their descriptions.

INTRODUCTION TO AUTOMOTIVE EMISSION CONTROL
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information sheets.

C. Make transparency.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Lead discussion about different types of automotive emission control systems.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheets

C. Transparency master #1--Photochemical Smog over City

D. Test

E. Answers to test

II. References:

A. *The Colorado Plan for the Control of Motor Vehicle Emissions.* Air Pollution Control Division/Colorado Department of Health. Interim Report, February 8, 1973.

B. *Vehicle Emission Control.* Detroit, Mich.: Gargano Promotions, 1973.

C. Glenn, Harold T. *Glenn's Emission Control Systems.* Chicago, Ill: Henry Regnery Co., 1972.

D. Pryde Lucy T. *Environmental Chemistry - An Introduction.* Menlo Park, California: Cummings Publishing Co., 1973.

E. Williamson, S. J. *Fundamentals of Air Pollution.* Reading, Mass.: Addison-Wesley Publishing Co., 1973.

F. Crouse, William H. and Donald L. Anglin. *The Auto Book*, second edition. New York: Gregg Division/McGraw-Hill Book Company, 1979.

G. U.S. Government. *The Clean Air Act-1974 Amendments.* Washington, D.C.: Environmental Protection Agency, 1974.

INTRODUCTION TO AUTOMOTIVE EMISSION CONTROL
UNIT I

INFORMATION SHEET

I. Automotive emission control--Any control that reduces pollutant emission from the automobile

II. Smog and photochemical smog (Transparency 1)

A. Smog--Condition resulting from the mixture of smoke, fog, and particulates

(NOTE: This condition has existed for some time in different parts of the world. It is attributed to the death of several hundred people.)

B. Photochemical smog--Condition that results from hydrocarbons and oxides of nitrogen chemically changing in the presence of sunlight

(NOTE: This condition can cause burning of the eyes, lung irritation, plant damage, the decomposition of rubber and possibly death.)

III. Sources of air pollution related to motor vehicles

A. Combustion as a result of the oxidation or burning of any substance in an automotive engine that can be used as a fuel

(NOTE: The results of this combustion give off hydrocarbons, carbon monoxide, particulates and oxides of nitrogen, all of which are considered air pollutants.)

B. Evaporation of liquid fuel into the atmosphere

(NOTE: Parts of the fuel itself, such as lead and sulfur, as well as asbestos from brake linings and rubber from the tires, are sources of air pollution.)

IV. Federal government involvement in regulation of motor vehicle emissions

A. 1963--Clean Air Act was enacted into law

B. 1965--Motor Vehicle Air Pollution Control Act amendments

C. 1970--Environmental Protection Agency (EPA) was established

(NOTE: One of the EPA's primary responsibilities is to aid the states in attaining a desirable air quality standard.)

INFORMATION SHEET

D. 1971--National standards for ambient air quality established

(NOTE: These standards set the limits for hydrocarbons, carbon monoxide, oxides of nitrogen and particulates. Standards for cars made in 1980 are as follows:

HC--0.41 gram per vehicle mile

CO--7.0 grams per vehicle mile

NO_x--2.0 grams per vehicle mile.)

V. Parts of the Clean Air Act which relate to automobile emissions

A. Title I, Section 101--General description of the act

B. Title II, Section 201, Part A--Motor Vehicle Emission and Fuel Standards

VI. Areas of automotive emission controls

A. Precombustion controls--Devices or systems that reduce emissions before combustion takes place

Examples: Evaporative emission system, heated air induction system

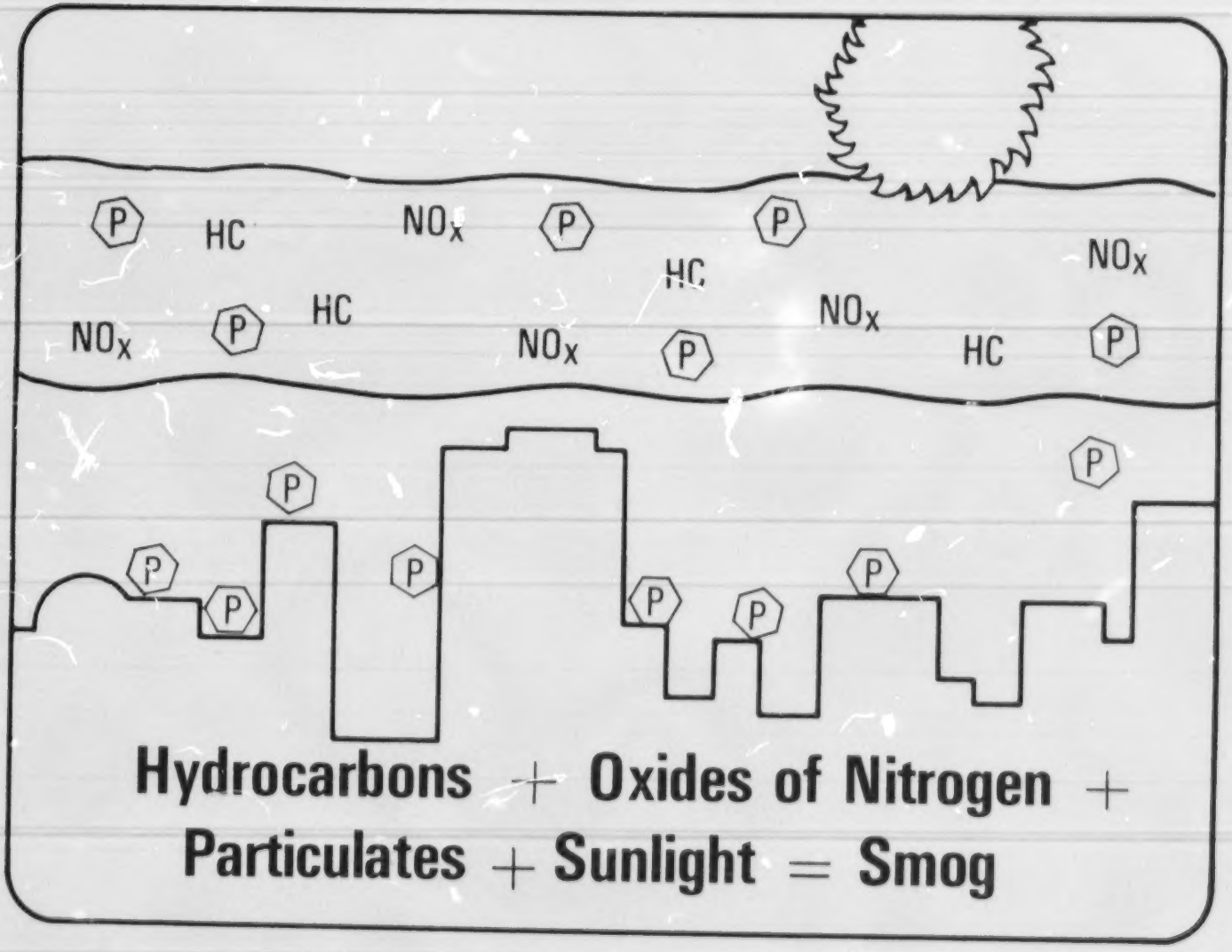
B. Combustion controls--Devices or systems that actually affect and control combustion to reduce emissions

Examples: Engine modifications, carburetor modifications

C. Postcombustion controls--Devices or systems that reduce emissions after combustion has occurred

Examples: Air injection system, catalytic converter systems

Photochemical Smog Over City



Hydrocarbons + Oxides of Nitrogen + Particulates + Sunlight = Smog

INTRODUCTION TO AUTOMOTIVE EMISSION CONTROL
UNIT I

NAME _____

TEST

1. Define automotive emission control.

2. Distinguish between smog and photochemical smog by placing the correct term to the left of the definitions.

   _____a. Condition that results from hydrocarbons and oxides of nitrogen chemically changing in the presence of sunlight

   _____b. Condition resulting from the mixture of smoke, fog, and particulates

3. List two sources of air pollution related to motor vehicles.

   a.

   b.

4. Describe briefly how the federal government has become involved in the regulation of motor vehicle emissions.

5. List the two parts of the Clean Air Act which relate to automobile emissions.

   a.

   b.

6. Match areas of automotive emission control on the right to the correct descriptions.

_____a.	Devices or systems that actually affect and control combustion to reduce emissions	1. Precombustion controls
_____b.	Devices or systems that reduce emissions after combustion has occurred	2. Combustion controls
_____c.	Devices or systems that reduce emissions before combustion takes place	3. Postcombustion controls

INTRODUCTION TO AUTOMOTIVE EMISSION CONTROL
UNIT I

ANSWERS TO TEST

1. Any control that reduces pollutant emission from the automobile

2. a. Photochemical smog

   b. Smog

3. a. Combustion as a result of the oxidation or burning of any substance in an automotive engine that can be used as a fuel

   b. Evaporation of liquid fuel into the atmosphere

4. Description should include:

   a. 1963--Clean Air Act was enacted into law

   b. 1965--Motor Vehicle Air Pollution Control Act amendments

   c. 1970--Environmental Protection Agency (EPA) was established

   d. 1971--National standards for ambient air quality established

5. a. Title I, Section 101--General description of the act

   b. Title II, Section 201, Part A--Motor Vehicle Emission and Fuel Standards

6. a. 2

   b. 3

   c. 1

INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT II

UNIT OBJECTIVE

After completion of this unit, the student should be able to select true statements about hydrocarbons and oxides of nitrogen and the formation of smog. The student should also be able to describe the health hazards of carbon monoxide and particulates. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with internal combustion engine pollutants to the correct definitions.
2. Select true statements about hydrocarbons and the formation of smog.
3. Select true statements about oxides of nitrogen and the formation of smog.
4. Describe the health hazards of carbon monoxide.
5. Describe the health hazards of particulates.

INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Hydrocarbons
2. TM 2--NO_x Formation
3. TM 3--Carbon Monoxide in Bloodstream
4. TM 4--Particulates

D. Test

E. Answers to test

III. References:

A. Patterson, D. J. and Heinan, N. A. *Emissions from Combustion Engines and Their Control.* Ann Arbor, Michigan: Ann Arbor Science Publishers, Inc., 1973.

B. Springer, G. S. and Patterson, D. J. *Engine Emissions Pollutant Formation and Measurement.* New York: Plenum Press, 1973.

C. Williamson, S. J. *Fundamentals of Air Pollution.* Reading, Massachusetts: Addison-Wesley Publishing Co., 1973.

INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Hydrocarbons--Compounds made up of hydrogen (H) atoms and carbon (C) atoms

B. Oxides of nitrogen--The chemical combination of nitrogen (N) and oxygen (O_2) during the combustion process; made up of 97-98% nitric oxide (NO_x) and 2-3% nitrogen dioxide (NO_2)

C. Carbon monoxide (CO)--An odorless, colorless, toxic gas that results from incomplete combustion

D. Particulates--Solid particles, primarily of lead from the fuel additives and carbon that are exhausted to the atmosphere

E. Unburned hydrocarbons--Hydrocarbon compounds that do not burn, but are emitted to the atmosphere

II. Hydrocarbons and the formation of smog (Transparency 1)

A. Hundreds of hydrocarbons are present in gasoline and fuel oil

B. Complete combustion of all fuel does not occur in the internal combustion engine

C. Some of the hydrocarbon compounds that do not burn are emitted to the atmosphere

D. The combination of nitrogen dioxide (NO_2), particulates, and unburned hydrocarbons in the presence of sunlight causes the formation of smog

III. Oxides of nitrogen and the formation of smog (Transparency 2)

A. Oxides of nitrogen are formed in the internal combustion engine when high combustion temperatures are reached

B. Oxides of nitrogen are made up of 97-98% nitric oxide (NO) and 2-3% nitrogen dioxide (NO_2)

C. When nitric oxide is exhausted into the atmosphere it combines with oxygen (O_2) to form nitrogen dioxide, which has a brownish color

D. The combination of nitrogen dioxide (NO_2), particulates, and unburned hydrocarbons in the presence of sunlight causes the formation of smog

INFORMATION SHEET

IV. Health hazards of carbon monoxide (Transparency 3)

(NOTE: Because of incomplete combustion, carbon monoxide (CO) is exhausted into the atmosphere. In complete combustion, the end product of combustion would be carbon dioxide and water, and nitrogen would pass through the combustion process unchanged.)

A. When carbon monoxide is inhaled into the lung, and transferred to the bloodstream, it replaces oxygen in the red blood cells, so the level of oxygen is reduced

B. This lack of oxygen in the bloodstream can cause headaches, reduced mental alertness, and even death if carbon monoxide concentrations are high enough

V. Health hazards of particulates (Transparency 4)

A. Lead emitted into the atmosphere poses a health threat in two ways

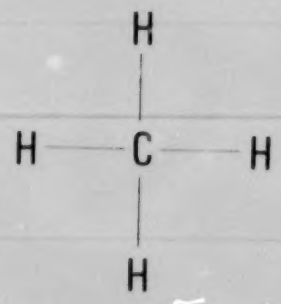
1. Respiratory intake of airborne lead during breathing

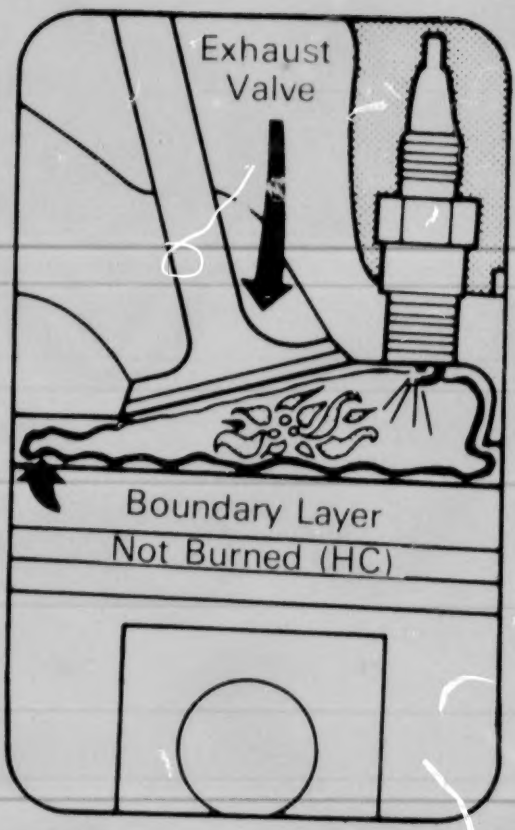
2. Contamination of food by lead that has settled in the soil

B. Since lead is a toxic substance, high concentrations of it in the body can cause damage to the brain, nervous system and kidneys, and can cause death

Hydrocarbons

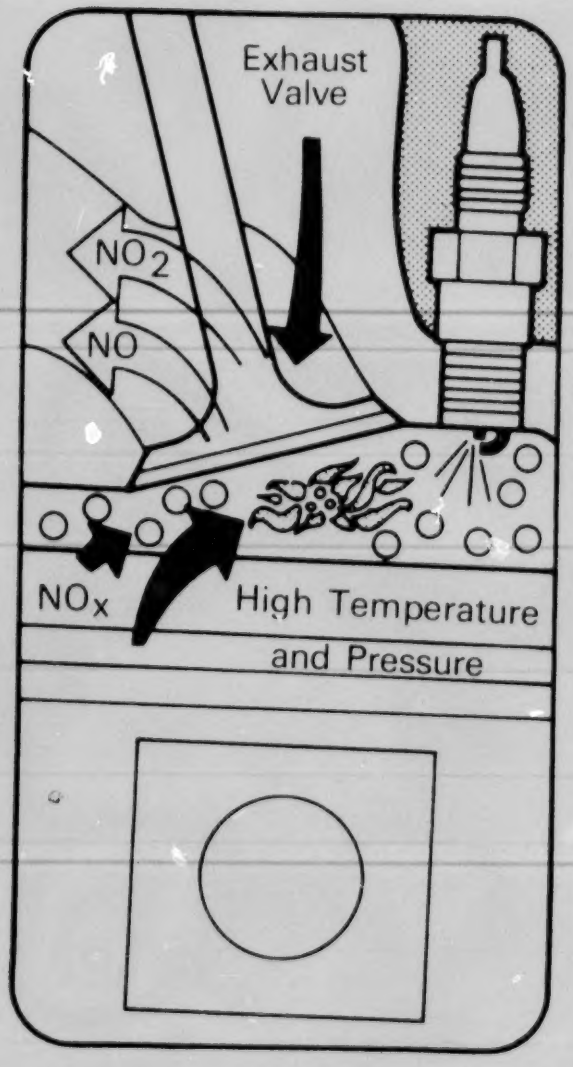
Gasoline and Diesel
and Oil



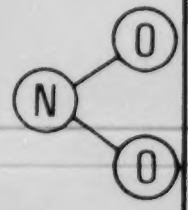


Particulates + HC
+ NOx = SMOG

NO_X Formation



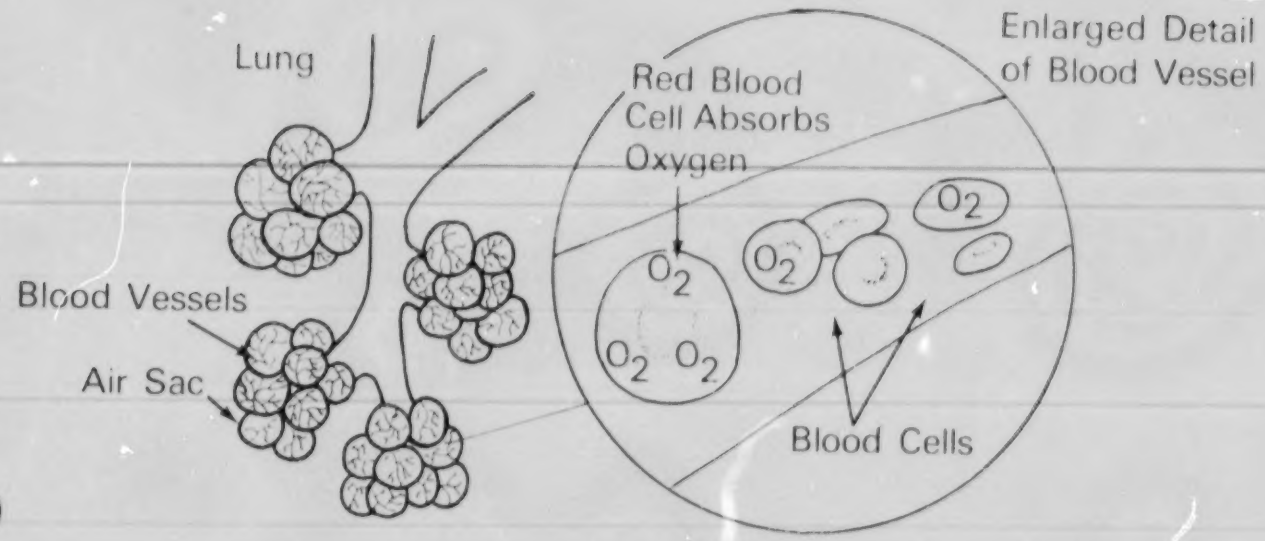
Nitrogen Dioxide =



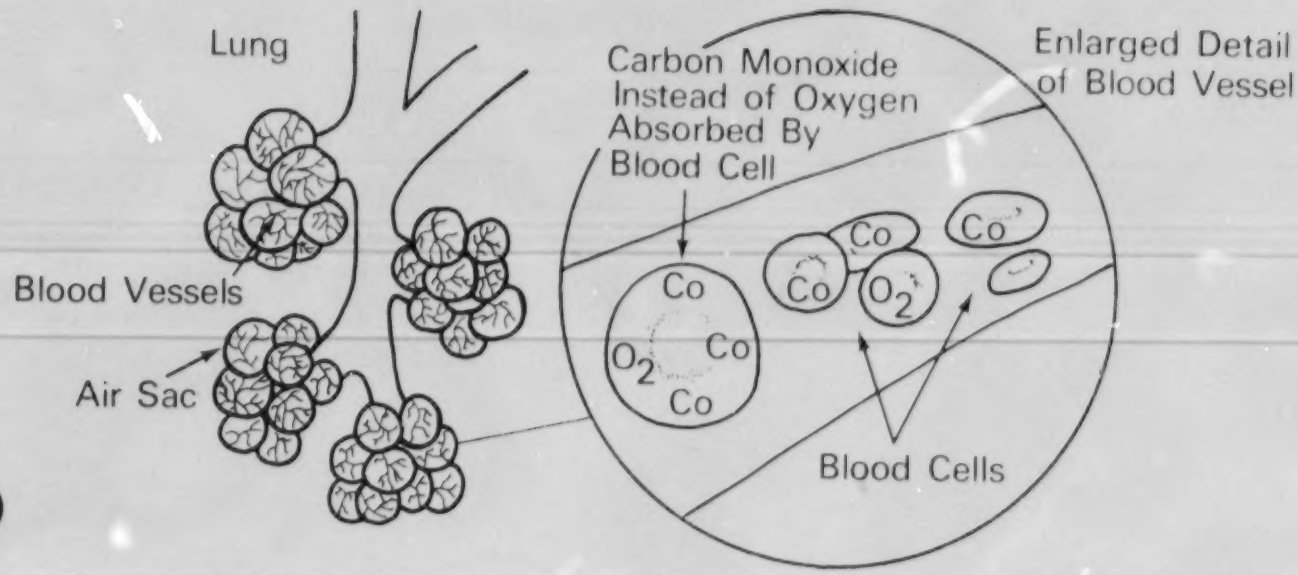
Nitrogen Combines
With Oxygen
Under Pressure
and Temperature
NO_X is NO and NO_2

Carbon Monoxide in Bloodstream

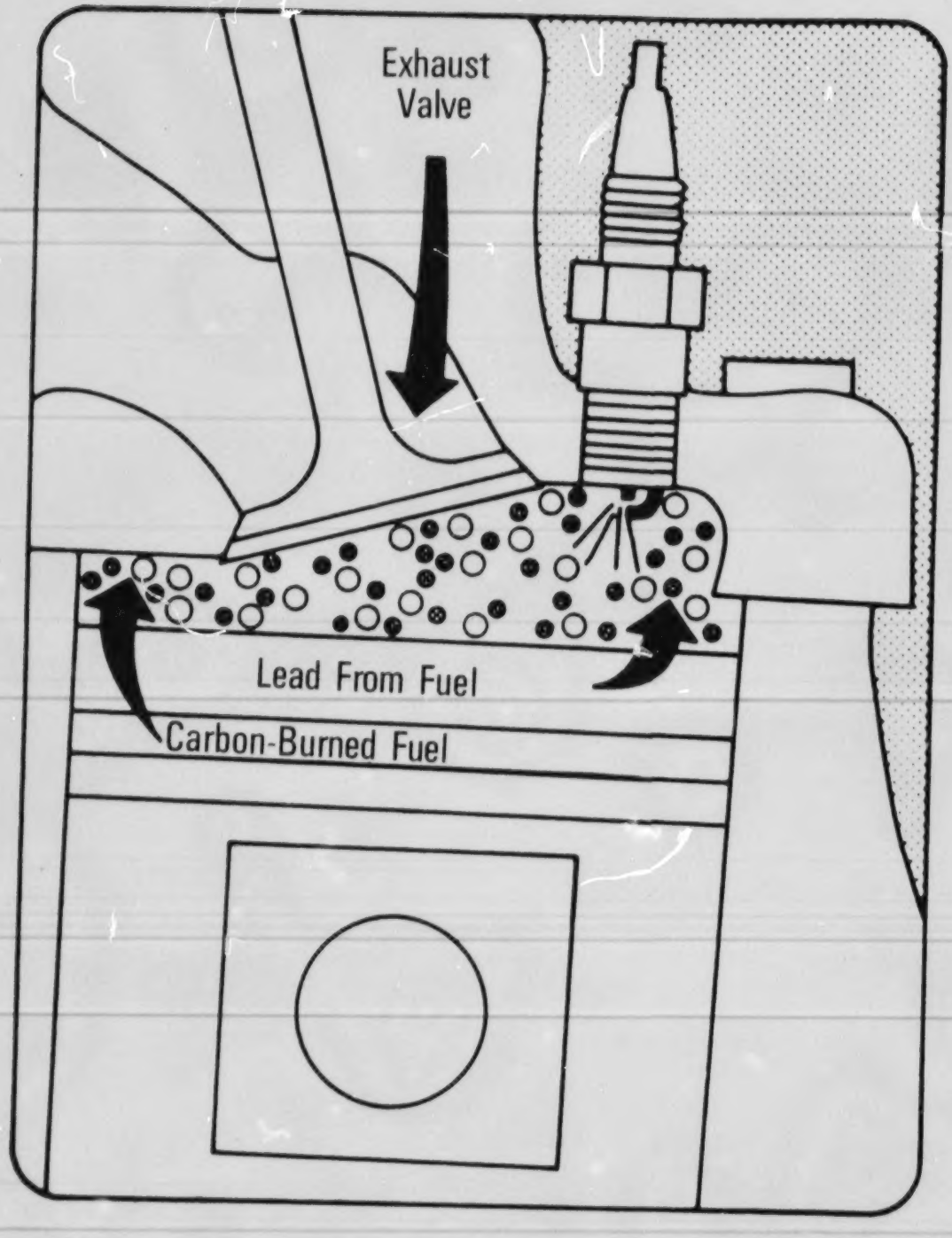
Normal Air Exchange



Carbon Monoxide Concentrated Air Exchange



Particulates



INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT II

NAME _____

TEST

1. Match the terms on the right to the correct definitions.

_____a. Compounds made up of hydrogen (H) atoms and carbon (C) atoms

_____b. The chemical combination of nitrogen (N) and oxygen (O_2) during the combustion process; made up of 97.98% nitric oxide (NO_x) and 2.3% nitrogen dioxide (NO_2)

_____c. An odorless, colorless, toxic gas that results from incomplete combustion

_____d. Solid particles, primarily of lead from the fuel additives and carbon that are exhausted to the atmosphere

_____e. Hydrocarbon compounds that do not burn, but are emitted to the atmosphere

1. Particulates
2. Carbon monoxide (CO)
3. Hydrocarbons
4. Unburned hydrocarbons
5. Oxides of nitrogen

2. Select true statements about hydrocarbons and the formation of smog by placing an "X" in the appropriate blanks.

_____a. Very few hydrocarbons are present in gasoline and fuel oil

_____b. Complete combustion of all fuel occurs in the internal combustion engine

_____c. Some of the hydrocarbon compounds that do not burn are emitted to the atmosphere

_____d. The combination of carbon monoxide and unburned hydrocarbons in the presence of sunlight causes the formation of smog

_____e. Complete combustion of all fuel does not occur in the internal combustion engine

_____f. The combination of nitrogen dioxide (NO_2), particulates, and unburned hydrocarbons in the presence of sunlight causes the formation of smog

3. Select true statements about oxides of nitrogen and the formation of smog by placing an "X" in the appropriate blanks.

_____a. Oxides of nitrogen are formed in the internal combustion engine when low combustion temperatures are present

_____b. Oxides of nitrogen are made up of 97-98% nitric oxide (NO) and 2-3% nitrogen dioxide (NO_2)

_____c. Oxides of nitrogen are made up of 2-3% nitric oxide (NO) and 97-98% nitrogen dioxide

_____d. When nitric oxide is exhausted into the atmosphere it combines with oxygen (O_2) to form nitrogen dioxide, which has a brownish color

_____e. The combination of nitrogen dioxide (NO_2), particulates, and unburned hydrocarbons in the presence of sunlight causes the formation of smog

4. Describe the health hazards of carbon monoxide.

a.

b.

5. Describe the health hazards of particulates.

a.

b.

INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 5
   c. 2
   d. 1
   e. 4
2. c, e, f
3. b, d, e
4. Description should include:
   a. When carbon monoxide is inhaled into the lung and transferred to the bloodstream, it replaces oxygen in the red blood cells, so the level of oxygen is reduced
   b. This lack of oxygen in the bloodstream can cause headaches, reduced mental alertness, and even death if carbon monoxide concentrates are high enough
5. Description should include:
   a. Lead emitted into the atmosphere poses a health threat in two ways
      1. Respiratory intake of airborne lead during breathing
      2. Contamination of food by lead that has settled in the soil
   b. Since lead is a toxic substance, high concentrations of it in the body can cause damage to the brain, nervous system and kidneys, and can cause death

ORIGIN OF INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT III

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the causes of incomplete combustion that result in unburned hydrocarbon emissions. The student should also be able to select true statements about the origins of carbon monoxide and nitric oxide emissions. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student will be able to:

1. Define terms associated with the origin of internal combustion engine pollutants.
2. List two sources of unburned hydrocarbon emissions during normal combustion.
3. Explain the causes of incomplete combustion that result in the emission of unburned hydrocarbons.
4. Select true statements about the origin of carbon monoxide (CO) emissions.
5. Select true statements about the origin of nitric oxide (NO_x) emissions.
6. List engine variables affecting NO_x emissions.

ORIGIN OF INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information sheets.

C. Make transparencies.

D. Discuss information sheet.

E. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Combustion Chamber Quench Areas

2. TM 2--Incomplete Combustion - Fuel System

3. TM 3--Air-Fuel Ratio Effect on Emissions

D. Test

E. Answers to test

II. References:

A. *Combustion in the Automotive Engine.* Denver, Colorado: Ethyl Technical Notes.

B. Glenn, Harold T. *Glenn's Emission Control Systems.* Chicago, Ill.: Henry Regnery Co., 1972.

C. Heinen, C. M. "We've Done the Job - What's Next?" *SAE Vehicle Emissions,* Part III, Vol. 14.

D. Heinen, N. A. and Patterson, D. J. *Emissions From Combustion Engines and Their Control.* Ann Arbor, Mich.: Ann Arbor Science Publications, Inc., 1972.

E. Springer, G. S. and Patterson, D. J. *Engine Emission Pollutant Formation and Measurement.* New York: Plenum Press, 1973.

F. Crouse, William H. and Donald L. Anglin. *The Auto Book.* New York: Gregg Division/McGraw Hili, 1979.

ORIGIN OF INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Quenching--The failure of the air-fuel mixture in a combustion chamber to ignite due to the transfer of heat from the mixture to the surface of the combustion chamber resulting in a fuel mixture which is too cool to ignite

B. Quench areas--Those areas in the combustion chamber where quenching will occur such as the walls, cavities, and small areas created by structural design, spark plug protrusion, or improperly fitted head gaskets (Transparency 1)

C. Combustion chamber deposits--Porous accumulations of carbon inside the combustion chamber which absorb small amounts of fuel mixture causing some unburned emissions to occur

II. Sources of unburned hydrocarbon emission during normal combustion

A. Quench areas

B. Combustion chamber deposits

III. Causes of incomplete combustion that result in the emission of unburned hydrocarbons (Transparency 2)

A. Ignition system--Any component of the ignition system that is worn or out of adjustment may cause a weak spark or a misfire to occur

B. Low air-fuel mixture temperature

1. Results in the poor atomization of fuel which results in an unevenly mixed air-fuel mixture

2. Has high localized concentrations of excessively rich mixtures and lean mixtures that do not burn evenly when ignited

C. Rich air-fuel mixtures--Mixtures that are too rich do not have enough oxygen to completely burn the amount of fuel present

D. Lean air-fuel mixtures--Can result in a misfire because the fuel is so diluted by air that it will not ignite properly

E. Excessive exhaust gas dilution

1. Occurs primarily during high manifold vacuum conditions such as engine idle or deceleration

INFORMATION SHEET

2. Results in a mixture that will not burn completely or can cause a complete misfire

IV. Origin of carbon monoxide emissions (Transparency 3)

A. Carbon monoxide (CO) is formed during the combustion process when there is not enough oxygen available to convert hydrocarbon (HC) to carbon dioxide (CO_2) and water (H_2O)

B. As the air-fuel mixture becomes richer than the ideal ratio of 15:1 there is an insufficient amount of oxygen present to complete the combustion process

C. This shortage of oxygen results in the incomplete conversion of CO to CO_2

D. An increase in the CO emissions is normally accompanied by an increase in HC emissions because of the lack of oxygen to completely burn all the fuel mixture

V. Origin of oxides of nitrogen (NO_x) emissions

A. Air that is drawn into the engine and mixed with the fuel supply is made up of approximately 78% nitrogen and 21% oxygen

B. The ignition of this mixture of air and fuel in the combustion chamber can result in temperatures in excess of 2700°C (4500°F).

C. Any engine variable that causes an increase in temperature above approximately 1082°C (2000°F) to 1357°C (2500°F) will cause an increase in NO_x emissions

VI. Engine variables affecting NO_x emissions (Transparency 3)

A. Ignition timing

(NOTE: As ignition timing is advanced more of the mixture is burned before the piston reaches top dead center (TDC). This causes increased pressures and temperatures in the combustion chamber which result in increased NO_x emissions. As timing is retarded, more of the mixture is burned on the power stroke and lower temperatures and pressures result in a decrease in NO_x emissions.)

B. Air-fuel mixture

(NOTE: Rich air-fuel mixtures cause incomplete combustion due to lack of oxygen. Lean air fuel mixtures cause incomplete combustion due to a lack of fuel. Lower combustion temperatures occur from either of these two conditions resulting in lower NO_x emissions.)

INFORMATION SHEET

C. Compression ratio

(NOTE: High combustion pressures increase NO_x emissions. Industry has lowered compression ratios to help reduce NO_x emission. Today's engines have a compression ratio of approximately 8 to 1 compared to 10 to 1 in 1969. However, reducing compression ratios also reduces the efficiency and performance of today's engines.)

D. Engine temperature

(NOTE: Higher engine operating temperatures increase combustion temperatures. Industry controls engine temperatures by use of pressurized cooling systems and engine coolant thermostats.)

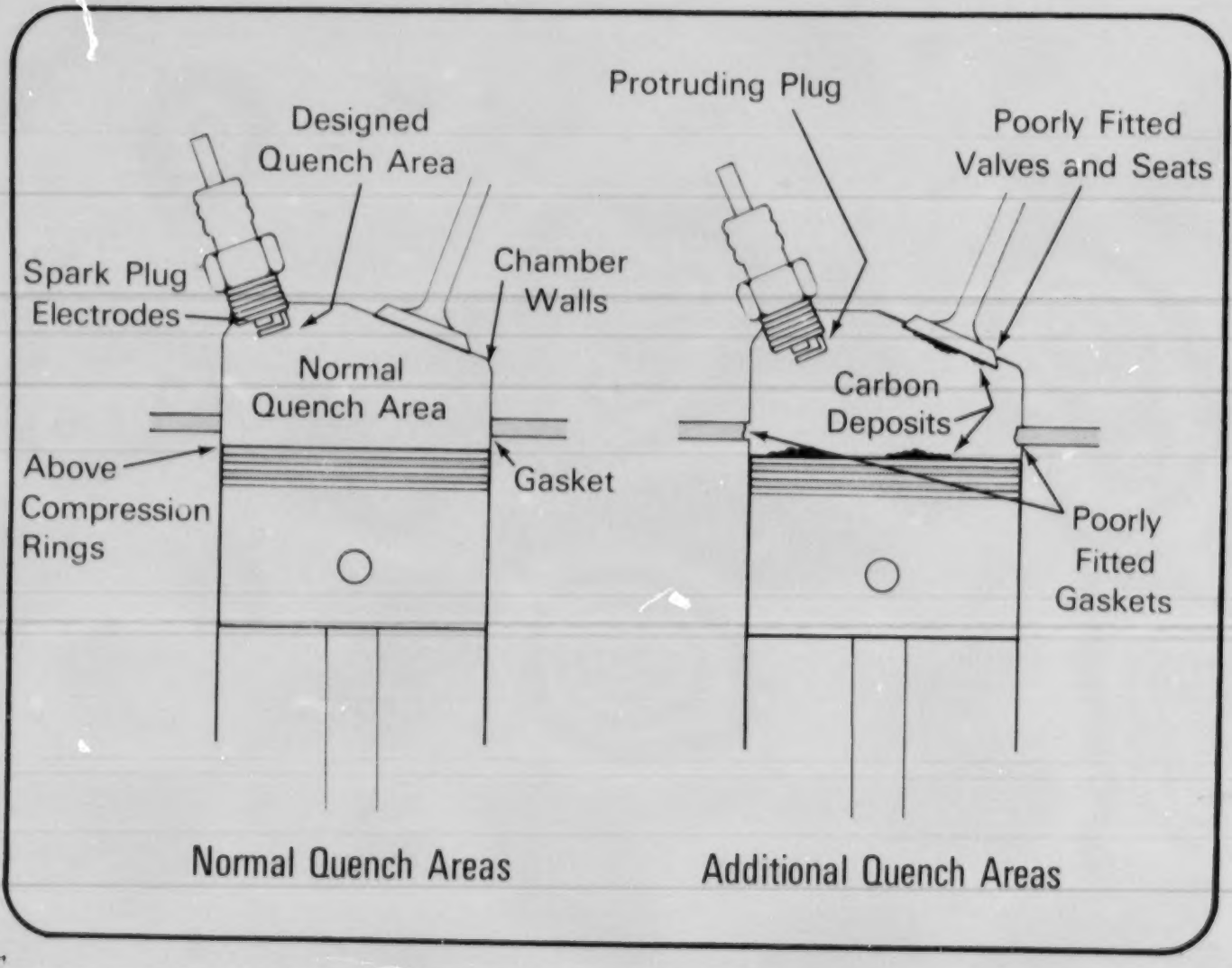
E. Exhaust gas recirculation (EGR)

(NOTE: Exhaust gases are mixed with air-fuel mixtures to absorb some of the heat of combustion and reduce combustion temperatures by the exhaust gas recirculation EGR system.)

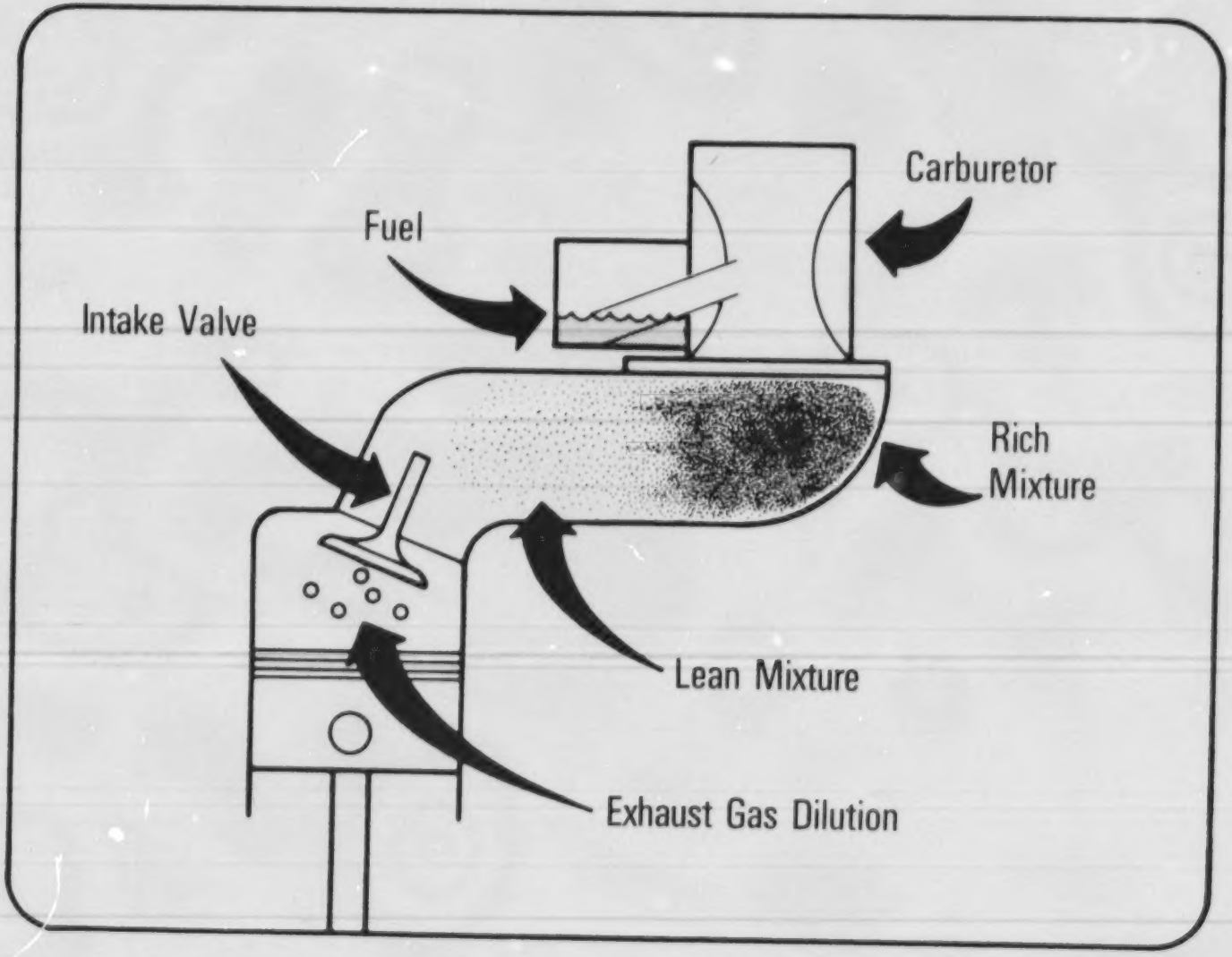
F. Exhaust gas dilution

(NOTE: Exhaust gas dilution occurs during high intake manifold vacuum conditions such as idle or deceleration. The dilution of the air-fuel mixture with exhaust gases decreases the temperatures reached during combustion and lowers NO_x emissions.)

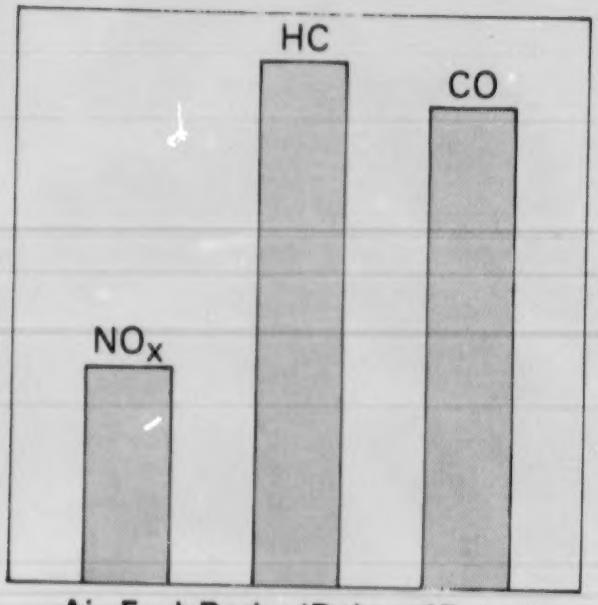
Combustion Chamber Quench Areas



Incomplete Combustion - Fuel System

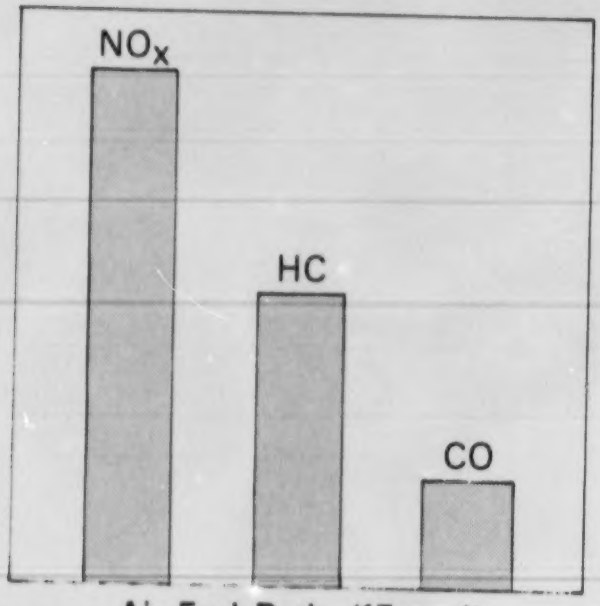


Air-Fuel Ratio Effect on Emissions



Pollutant Concentration

Air Fuel Ratio (Below 15 to 1)



Pollutant Concentration

Air Fuel Ratio (15 to 1)

TM 3

ORIGIN OF INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT III

NAME _____

TEST

1. Define terms associated with the origin of internal combustion engine pollutants.

   a. Quenching--

   b. Quench areas--

   c. Combustion chamber deposits--

2. List two sources of unburned hydrocarbon emissions during normal combustion.

   a.

   b.

3. Explain the causes of incomplete combustion that result in the emission of unburned hydrocarbons.

   a. Ignition system--

   b. Low air-fuel mixture temperature

      1.

      2.

   c. Rich air-fuel mixtures--

   d. Lean air-fuel mixtures--

   e. Excessive exhaust gas dilution

      1.

      2.

4. Select true statements about the origin of carbon monoxide (CO) emissions by placing an "X" in the appropriate blanks.

   _____a. Carbon monoxide (CO) is formed during the combustion process when there is not enough oxygen available to convert hydrocarbon (HC) to carbon dioxide (CO_2) and water (H_2O)

   _____b. As the air-fuel mixture becomes leaner than the ideal ratio of 15:1 there is an insufficient amount of carbon present to complete the combustion process

   _____c. This shortage of oxygen results in the complete conversion of CO to CO_2

   _____d. An increase in the CO emissions is normally accompanied by an increase in HC emissions because of the lack of oxygen to completely burn all the fuel mixture

5. Select true statements about the origin of nitric oxide (NO_x) emissions by placing an "X" in the appropriate blanks.

   _____a. Air that is drawn into the engine and mixed with the fuel supply is made up of approximately 78% oxygen and 21% nitrogen

   _____b. The ignition of this mixture of air and fuel in the combustion chamber can result in temperatures in excess of 2700°C (4500°F)

   _____c. Any engine variable that causes an increase in temperature above approximately 1082°C (2000°F) to 1357°C (2500°F) will cause an increase in NO_x emissions

6. List five engine variables affecting NO_x emissions.

   a.

   b.

   c.

   d.

   e.

ORIGIN OF INTERNAL COMBUSTION ENGINE POLLUTANTS
UNIT III

ANSWERS TO TEST

1. a. The failure of the air-fuel mixture in a combustion chamber to ignite due to the transfer of heat from the mixture to the surface of the combustion chamber resulting in a fuel mixture which is too cool to ignite

   b. Those areas in the combustion chamber where quenching will occur such as the walls, cavities, and small areas created by structural design, spark plug protrusion, or improperly fitted head gaskets

   c. Porous accumulations of carbon inside the combustion chamber which absorb small amounts of fuel mixture causing some unburned emissions to occur

2. a. Quench areas

   b. Combustion chamber deposits

3. Explanation should include:

   a. Any component of the ignition system that is worn or out of adjustment may cause a weak spark or a misfire to occur

   b. 1. Results in the poor atomization of fuel which results in an unevenly mixed air-fuel mixture

      2. Has high localized concentrations of excessively rich mixtures and lean mixtures that do not burn evenly when ignited

   c. Mixtures that are too rich do not have enough oxygen to completely burn the amount of fuel present

   d. Can result in a misfire because the fuel is so diluted by air that it will not ignite properly

   e. 1. Occurs primarily during high manifold vacuum conditions such as engine idle or deceleration

      2. Results in a mixture that will not burn completely or can cause a complete misfire

4. a, d

5. b, c

6. Any five of the following:

   a. Ignition timing

   b. Air-fuel mixture

   c. Compression ratio

   d. Engine temperature

   e. Exhaust gas recirculation (EGR)

   f. Exhaust gas dilution

HEATED AIR INDUCTION SYSTEMS
UNIT IV

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the purpose of the heated air induction system and explain the function of both the vacuum motor type and thermostatically controlled type system. The student should be able to visually inspect, test, disassemble, and reassemble both systems. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with heated air induction systems to their correct definitions.
2. Write the purpose of the heated air induction system.
3. List two types of heated air induction systems.
4. Explain the operation of both types of heated air induction systems from cold-start conditions to conditions at normal operating temperatures.
5. Demonstrate the ability to:
   a. Determine the proper operation of the vacuum motor system and the thermostatically controlled system.
   b. Check vacuum diaphragm unit for leaks.
   c. Check for proper operation of a thermostatically controlled system.
   d. Check for proper operation of a vacuum controlled system.
   e. Check for proper operation of vacuum override unit.

HEATED AIR INDUCTION SYSTEMS
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined in job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheets.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheets

C. Transparency masters

1. TM 1--Basic Air Flow
2. TM 2--Vacuum Motor System
3. TM 3--Thermostatically Controlled Unit
4. TM 4--Vacuum Override Operation

D. Job sheets

1. Job Sheet #1--Determine the Proper Operation of the Vacuum Motor System and the Thermostatically Controlled System

2. Job Sheet #2--Check Vacuum Diaphragm Unit for Leaks

3. Job Sheet #3--Check for Proper Operation of a Thermostatically Controlled System

4. Job Sheet #4--Check for Proper Operation of a Vacuum Controlled System

5. Job Sheet #5--Check for Proper Operation of Vacuum Override Unit

E. Test

F. Answers to test

II. References:

A. Chrysler Corporation. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Service Department, 1978.

B. Glenn, Harold T. *Glenn's Emission Control Systems.* Chicago, Ill.: Henry Regnery Co., 1972.

C. Gargano Promotions. *Vehicle Emission Control.* Detroit, Michigan: Gargano Promotions, 1973.

D. Ford Motor Company. *Vehicle Emission Control System.* Detroit, Michigan: Helm, Incorporated Service Publications, 1978.

E. General Motors Corporation. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

HEATED AIR INDUCTION SYSTEMS
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Manifold stove (shroud)--A device which directs air flow over the exhaust manifold to preheat it

(NOTE: This generally consists of a metal housing around the exhaust manifold which is connected to the air cleaner by a tube assembly.)

B. Hot air pipe--A tube assembly that connects the manifold stove to the air cleaner

(NOTE: In some applications the manifold stove and hot air pipe are one unit.)

C. Damper--A deflector device that controls air supply to the air cleaner

(NOTE: The position of the damper determines whether intake air comes from the hot air pipe, engine compartment, or from a combination of both sources.)

D. Vacuum motor--A vacuum operated diaphragm assembly which controls the position of the damper

(NOTE: The vacuum motor operates on a combination of engine vacuum and spring tension to change the damper direction according to engine and outside air temperatures.)

E. Thermostat--A temperature sensitive metal bar

(NOTE: The bar expands or shrinks in length according to the surrounding air temperature and, because it is attached directly to the damper assembly, causes the damper to change position.)

F. Temperature sensor--A bimetal or temperature sensitive plate

(NOTE: The sensor acts as a thermostat to open or close a valve attached to it which directs vacuum to the motor of the damper assembly.)

G. Vacuum override motor--A vacuum controlled motor that regulates air intake during periods of cold acceleration

(NOTE: During normal operating conditions engine vacuum is high, keeping the override motor nonfunctional. But when the vacuum drops, as during cold acceleration conditions, spring tension overcomes the vacuum. When this happens, the motor positions the damper so that a combination of heated and engine compartment air enters the air cleaner to improve engine performance.)

INFORMATION SHEET

H. Air cleaner--A metal housing containing filtering material located between the carburetor and the air intake which removes foreign particles from intake air

(NOTE: Most air cleaners have disposable paper elements which filter the air entering the carburetor. The air intake component of the air cleaner (snorkle tube) generally houses the damper assembly.)

II. Purpose of the heated air induction system (Transparency 1)--The purpose of the heated air induction system is to maintain air intake temperatures at approximately 37.7°C (100°F) or higher

(NOTE: The heated air induction system is used to compensate for the leaner air-fuel mixtures currently used and also provides better engine warm-up characteristics. This system reduces HC and CO emissions.)

III. Types of heated air induction systems

A. Vacuum motor system

B. Thermostatically controlled system

IV. Operation of heated air induction systems from cold-start conditions to conditions at normal operating temperature

A. Vacuum motor system (Transparency 2)

(NOTE: When the engine is started under conditions where engine compartment air temperature is less than 37.7°C (100°F), the following sequence occurs.)

1. Temperature sensor holds the vacuum motor control valve closed, preventing vacuum bleed
2. Manifold vacuum is directed to the vacuum motor
3. Motor positions the damper assembly to allow air from the manifold stove to enter the air cleaner until the air temperature reaches 37.7°C (100°F)
4. When air temperature in engine compartment reaches 37.7°C (100°F), the temperature sensor partially opens the vacuum motor valve
5. Vacuum is bled off reducing the amount of vacuum to vacuum motor
6. Spring tension in vacuum motor causes the motor to position the damper so that preheated air is mixed with engine compartment air before entering the air cleaner
7. As the temperature in the engine compartment increases, the vacuum motor valve bleeds off all vacuum to cut off the manifold vacuum supply to the vacuum motor

INFORMATION SHEET

8. Under low vacuum conditions, the spring tension in the motor positions the damper so that only engine compartment air enters the air cleaner

B. Thermostatically controlled system (Transparencies 3 and 4)

(NOTE: When the engine is started under conditions where engine compartment air temperature is less than 37.7°C (100°F), the following sequence occurs.)

1. Thermostat assembly is fully contracted

2. Damper assembly attached to the thermostat is positioned to allow only preheated air to enter the air cleaner assembly (heat on position)

3. When air in engine compartment reaches a temperature of 37.7°C (100°F) the thermostat begins to increase in size

4. Damper assembly is positioned by the thermostat to allow some engine compartment air to mix with the preheated air before entering the air cleaner (partial heat on position)

5. When the air temperature is greater than 37.7°C (100°F), the thermostat becomes fully extended

6. Damper is positioned by the thermostat to allow only air compartment air to enter the air cleaner (heat off position)

7. During conditions of cold acceleration, a drop in manifold vacuum causes the spring tension in the vacuum override motor to change the damper position

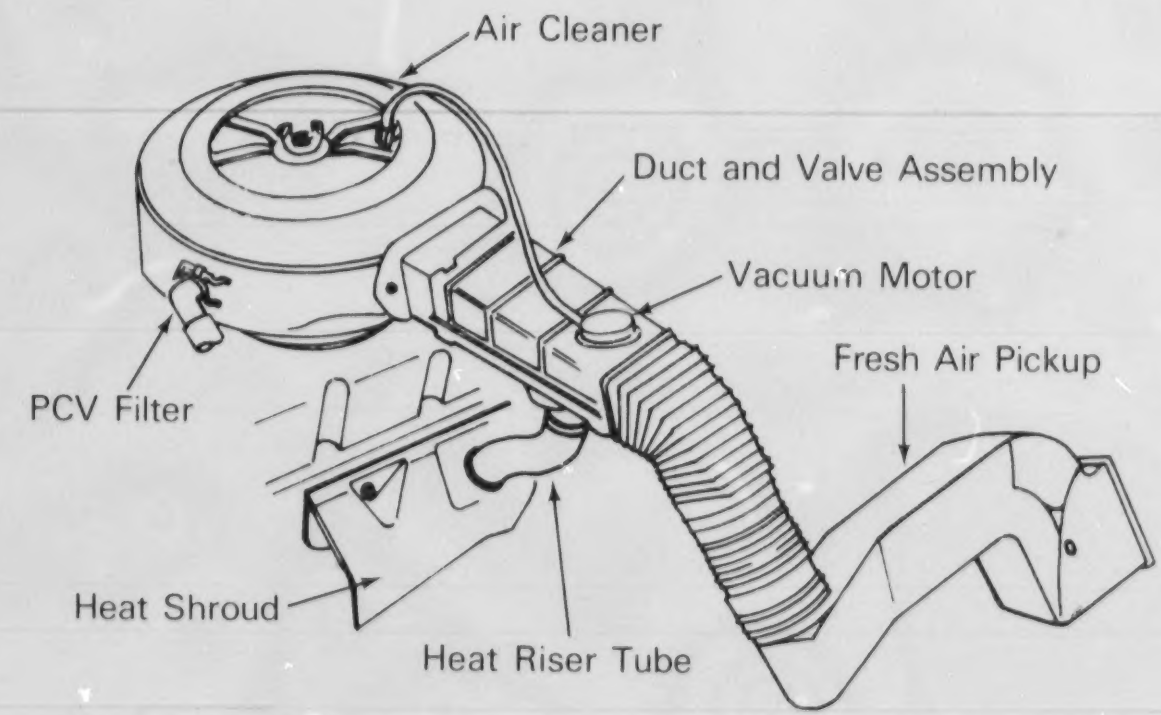
   (NOTE: Under normal high vacuum conditions, spring tension is overcome by the vacuum diaphragm in the motor.)

8. Damper is positioned to the partial heat on position

   (NOTE: This provides for better engine performance when engine load conditions are greater under cold acceleration.)

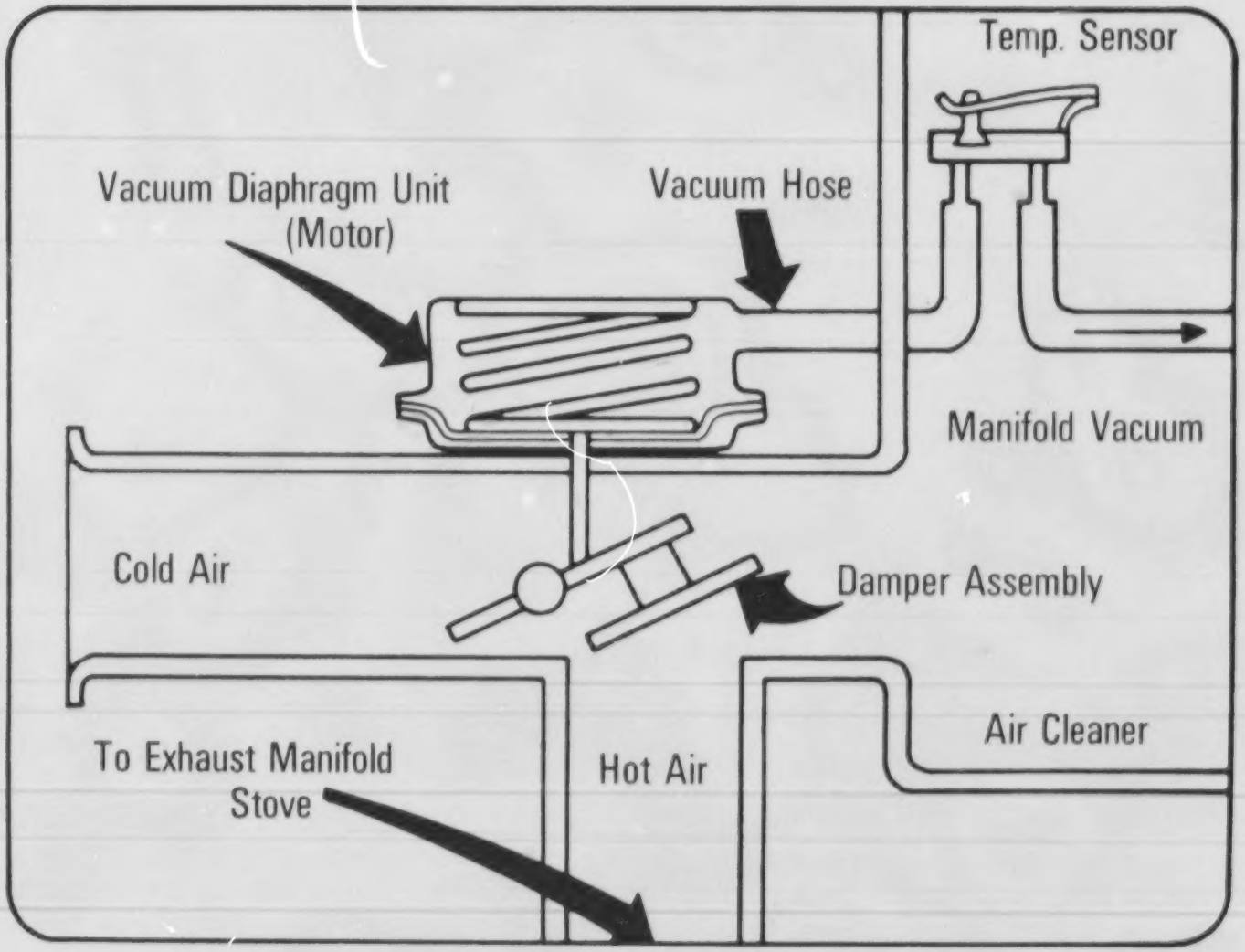
9. Override motor holds the damper in partial heat on position until a high vacuum condition exists at which time the damper returns to heat off position for normal operation

Basic Air Flow



Air Heated by Manifold Stove
(Air Induction Reduces HC & CO)

Vacuum Motor System

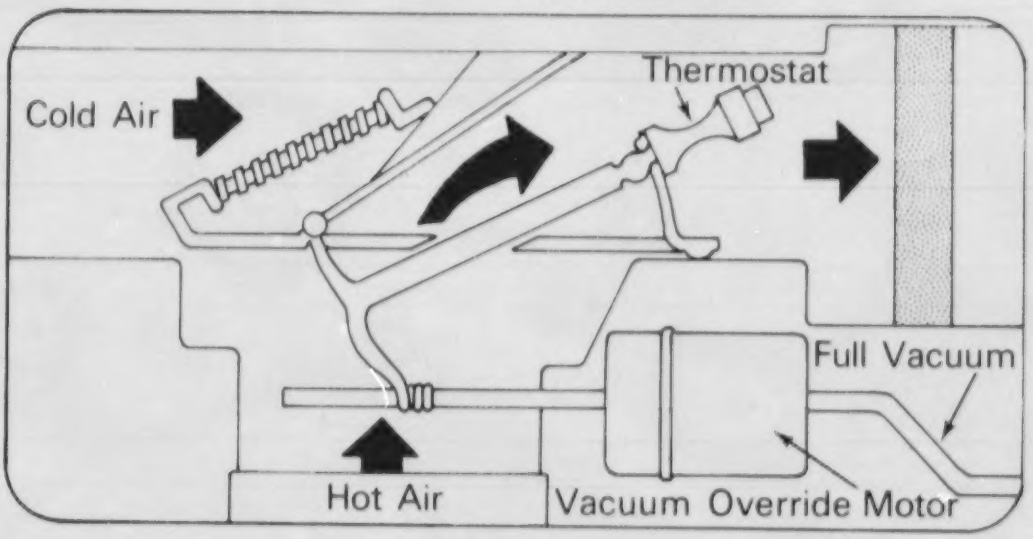


TM 2

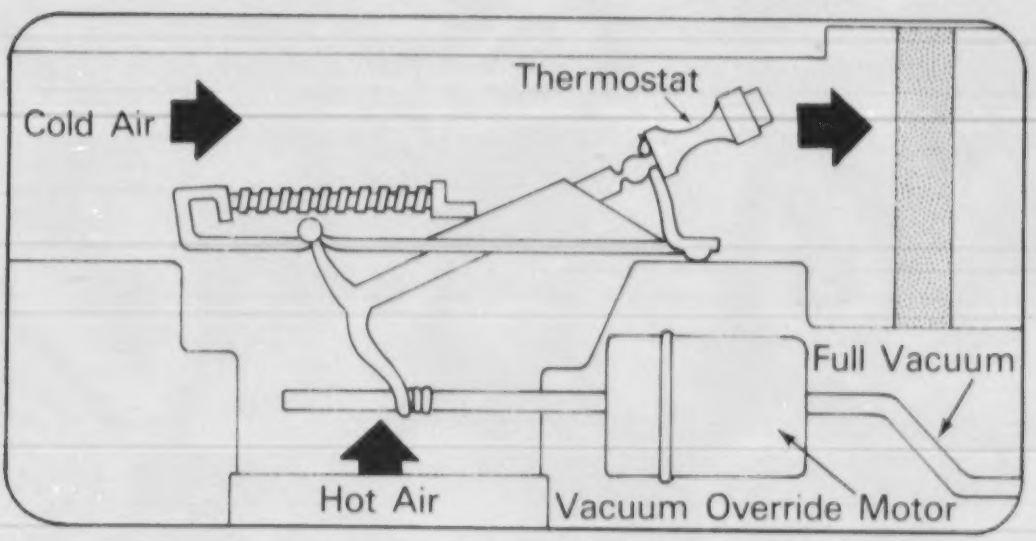
AEC 59

Thermostatically Controlled Unit

Heat On Position (Warm-up)

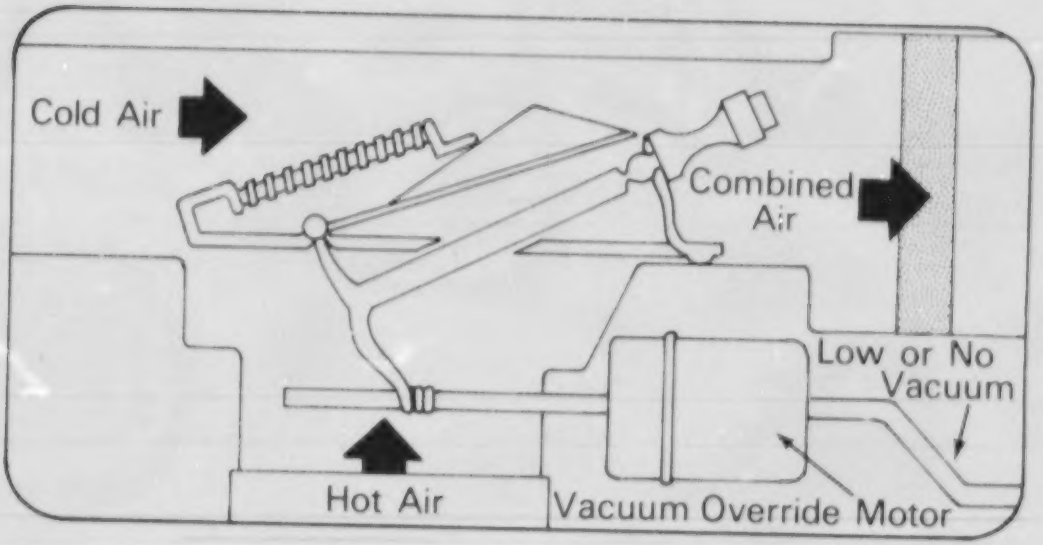


Heat Off Position (Warm Engine)



Vacuum Override Operation

(Cold Acceleration)



HEATED AIR INDUCTION SYSTEMS
UNIT IV

JOB SHEET #1--DETERMINE THE PROPER OPERATION OF THE VACUUM MOTOR SYSTEM AND THE THERMOSTATICALLY CONTROLLED SYSTEM

I. Tools required

A. Thermometer

B. Vacuum pump

II. Procedure

A. Check engine compartment temperature (should be less than 37.7°C [100°F]

(NOTE: Engine should be cold.)

B. Check that all vacuum hoses are tight and in good condition, where applicable

C. Check that the hot air pipe is securely attached to manifold stove and air cleaner

D. Start engine

(NOTE: Damper assembly should be up (heat on position).)

E. Warm up engine

F. Check temperature at snorkel inlet or temperature sensor

(NOTE: If 40.1°C [105°F] or higher, damper assembly should be down [heat off position].

(NOTE: These are BASIC PROCEDURES. Check the proper manufacturers technical or shop manual for exact procedures and settings for each make and model.)

HEATED AIR INDUCTION SYSTEMS
UNIT IV

JOB SHEET #2 CHECK VACUUM DIAPHRAGM UNIT FOR LEAKS

I. Tools required

A. Vacuum pump

B. Vacuum gauge

C. Bleed valve

D. Shutoff valve

II. Procedure

A. Remove air cleaner assembly

B. Attach vacuum pump and gauge to vacuum diaphragm unit

C. Start pump

D. Close down bleed valve until vacuum shows 20" Hg

E. Close shutoff valve

F. Turn off pump

(NOTE: Vacuum diaphragm unit should hold 20" Hg for 5 minutes.)

G. Release vacuum

H. Start pump

I. With bleed valve build vacuum slowly and observe that:

1. The damper should begin to lift at not less than 5" Hg

2. The damper should be fully open with no more than 9" Hg

(NOTE: These are BASIC PROCEDURES. Check the proper manufacturer's technical or shop manual for exact procedures and settings for each make and model.)

HEATED AIR INDUCTION SYSTEMS
UNIT IV

JOB SHEET #3 CHECK FOR PROPER OPERATION OF A THERMOSTATICALLY CONTROLLED SYSTEM

I. Tools and equipment

A. Thermometer

B. External heat source

C. Freon canister

(NOTE: A common hair dryer provides an excellent heat source. A wet rag will sufficiently cool down thermostats.)

II. Procedure

A. Remove air cleaner cover

B. Remove air filter element

C. Check position of damper assembly

(NOTE: The damper assembly should be in "heat on" position if the air temperature is below 37.7°C [100°F.]

D. Apply heat to the thermostat and check for proper movement of damper assembly

E. Apply freon gas from canister to thermostat and check for proper operation of damper assembly

(NOTE: Freon gas is used to simulate cold conditions and to speed up the process to save time in the shop environment. A wet rag can be used also.)

F. If the damper assembly does not move properly, check for misalignment and binding and adjust mechanisms as needed

G. If no movement is noted and no binding is found, replace the faulty component

(NOTE: These are BASIC PROCEDURES. For exact procedures and settings, check manufacturer's shop manual.)

HEATED AIR INDUCTION SYSTEMS
UNIT IV

JOB SHEET #4 CHECK FOR PROPER OPERATION OF A VACUUM CONTROLLED SYSTEM

I. Tools and equipment

A. Thermostat

B. External heat source

(NOTE: A common hair dryer provides an excellent heat source.)

C. Freon canister

(NOTE: A wet rag can be used to cool down assemblies.)

II. Procedure

A. Remove air cleaner cover

B. Remove air filter element

C. Check position of damper assembly

(NOTE: The damper assembly should be in the "heat on" position if the air temperature is below 37.7°C [100°F.]

D. Start the engine to provide vacuum to valve

E. Apply heat to the temperature sensor and check for proper movement of damper assembly

F. Apply freon gas to the temperature sensor and check for proper movement of damper assembly

(CAUTION: Be sure to stop the engine before using freon to cool the assembly. A wet rag can be used without danger.)

G. If the damper assembly does not move properly, check for misalignment or binding and adjust the mechanism as needed

(NOTE: The temperature sensor and valve assembly should move upward when heated and return to a closed position when cooled. This can be visually determined when heat or cold is applied.)

H. If damper assembly does not move properly and no binding or misalignment is found, replace the faulty components or locate and replace loose vacuum lines as needed

(NOTE: These are BASIC PROCEDURES. For exact procedures and settings, check the manufacturer's shop manual.)

HEATED A.R INDUCTION SYSTEMS
UNIT IV

JOB SHEET #5-CHECK FOR PROPER OPERATION OF
VACUUM OVERRIDE UNIT

I. Tools and equipment-Vacuum gauge

II. Procedure

(NOTE: Engine should be cold.)

A. Disconnect hose from vacuum override unit

B. Connect vacuum gauge to hose

C. Start engine

(NOTE: At idle, vacuum should be 15" or greater. If less than 15" check for leaks in hose or at fitting on manifold.)

D. Check to see if damper is partly open to admit both engine compartment air and heated air

E. Remove vacuum gauge

F. Connect vacuum hose to vacuum override motor

G. Check to see if damper moves to heat on position

H. If damper does move to heat on position, the vacuum override motor should be replaced

(NOTE: These are BASIC PROCEDURES. Check the proper manufacturer's technical or shop manual for exact procedures and settings for each make and model.)

HEATED AIR INDUCTION SYSTEMS
UNIT IV

NAME _____

TEST

1. Match the terms on the right to the correct definitions.

_____a.	A metal housing containing filtering material located between the carburetor and the air intake which removes foreign particles from intake air	1. Manifold stove (shroud)
_____b.	A vacuum controlled motor that regulates air intake during periods of cold acceleration	2. Vacuum motor
_____c.	A bimetal or temperature sensitive plate	3. Thermostat
_____d.	A temperature sensitive metal bar	4. Vacuum override motor
_____e.	A vacuum operated diaphragm assembly which controls the position of the damper	5. Air cleaner
_____f.	A deflector device that controls air supply to the air cleaner	6. Temperature sensor
_____g.	A tube assembly that connects the manifold stove to the air cleaner	7. Damper
_____h.	A device which directs air flow over the exhaust manifold to preheat it	8. Hot air pipe

2. Write the purpose of the heated air induction system.

3. List two types of heated air induction systems.

   a.

   b.

4. Explain the operation of both types of heated air induction systems from cold start conditions to conditions at normal operating temperature.

   a.

   b.

5. Demonstrate the ability to:

   a. Determine the proper operation of the vacuum motor system and thermostatically controlled system.

   b. Check vacuum diaphragm unit for leaks.

   c. Check for proper operation of a thermostatically controlled system.

   d. Check for proper operation of a vacuum controlled system.

   e. Check for proper operation of vacuum override unit

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

HEATED AIR INDUCTION SYSTEMS
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 4
   c. 6
   d. 3
   e. 2
   f. 7
   g. 8
   h. 1

2. The purpose of the heated air induction system is to maintain air intake temperatures at approximately 37.7°C (100°F) or higher

3. a. Vacuum motor system
   b. Thermostatically controlled system

4. Explanation should include:
   a. Vacuum motor system
      1) Temperature sensor holds the vacuum motor control valve closed, preventing vacuum bleed
      2) Manifold vacuum is directed to the vacuum motor
      3) Motor positions the damper assembly to allow air from the manifold stove to enter the air cleaner until the air temperature reaches 37.7°C (100°F)
      4) When air temperature in engine compartment reaches 37.7°C (100°F), the temperature sensor partially opens the vacuum motor valve
      5) Vacuum is bled off reducing the amount of vacuum to vacuum motor
      6) Spring tension in vacuum motor causes the motor to position the damper so that preheated air is mixed with engine compartment air before entering the air cleaner
      7) As the temperature in the engine compartment increases, the vacuum motor valve bleeds off all vacuum to cut off the manifold vacuum supply to the vacuum motor

8) Under low vacuum conditions, the spring tension in the motor positions the damper so that only engine compartment air enters the air cleaner

b. Thermostatically controlled system

1) Thermostat assembly is fully contracted

2) Damper assembly attached to the thermostat is positioned to allow only preheated air to enter the air cleaner assembly (heat on position)

3) When air in engine compartment reaches a temperature of 37.7°C (100°F) the thermostat begins to increase in size

4) Damper assembly is positioned by the thermostat to allow some engine compartment air to mix with the preheated air before entering the air cleaner (partial heat on position)

5) When the air temperature is greater than 37.7°C (100°F), the thermostat becomes fully extended

6) Damper is positioned by the thermostat to allow only air compartment air to enter the air cleaner (heat off position)

7) During conditions of cold acceleration, a drop in manifold vacuum causes the spring tension in the vacuum override motor to change the damper position

8) Damper is positioned to the partial heat on position

9) Override motor holds the damper in partial heat on position until a high vacuum condition exists at which time the damper returns to heat off position for normal operation

5. Performance skills evaluated to the satisfaction of the instructor

EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to match the functions of the evaporative emissions control system to the components and explain the operation of a basic evaporative emissions control system. The student should also be able to visually inspect, test, and service the evaporative emission control system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write the purpose of the evaporative emissions control system.
2. Match components of the evaporative emissions control system to their functions.
3. List four methods of carburetor vapor control.
4. Explain the operation of the evaporative emissions control system.
5. Demonstrate the ability to:
   a. Change the charcoal canister filter.
   b. Test the fuel tank filler cap.

EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Fuel Tank With Thermal Expansion Volume
2. TM 2--Pressure-Vacuum Relief Filler Cap
3. TM 3--Vapor-Liquid Separator
4. TM 4--Charcoal Canister

5. TM 5--Charcoal Canister Purging Methods

6. TM 6--Charcoal Canister Purging Methods (Continued)

7. TM 7--Charcoal Canister Purging Methods (Continued)

D. Job sheets

1. Job Sheet #1--Change the Charcoal Canister Filter

2. Job Sheet #2--Test the Fuel Tank Filler Cap

E. Test

F. Answers to test

II. References:

A. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Mich.: Service Section/General Motors Corp., 1979.

B. Chrysler Corporation, *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Service Department, 1978.

C. Glenn, Harold T. *Glenn's Emission Control Systems.* Chicago, Illinois: Henry Regnery Company, 1972.

D. Gargano Promotions. *Vehicle Emission Control.* Detroit, Mich.: Gargano Promotions, 1973.

E. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

INFORMATION SHEET

I. Purpose of the evaporative emission controls system--The evaporative emissions control system controls the release of hydrocarbons (HC) to the atmosphere that results from fuel vapors escaping from fuel tanks and carburetor vents

II. Components and functions of the evaporative emissions control system

A. Fuel tank--A sealed unit for storing fuel that has a built in air space (approximately 11% of tank volume) to allow for fuel expansion due to temperature increases (Transparency 1)

B. Fuel tank filler cap--Seals the fuel tank and acts as a relief valve to protect the fuel tank from excessive pressure or vacuum (Transparency 2)

C. Vapor vent lines--Allow vapors to be directed from the fuel tank to a vapor-liquid separator and to the charcoal canister

D. Vapor-liquid separator--Prevents passage of fuel to the carbon canister by means of either a float valve which seals off the line where fuel enters or by a series of standpipes (Transparency 3)

(NOTE: The standpipes are set at different heights to allow fuel to return to the tank and only vapors to escape.)

E. Charcoal canister--Traps and stores fuel vapors by means of activated charcoal contained in a sealed unit (Transparencies 4, 5, 6, and 7)

(NOTE: Fuel vapors are vented to the carburetor by purging the canister container with fresh air during normal engine operation.)

F. Rollover check valve--Prevents the spillage of fuel from the fuel system in the event of rollover of the automobile

(NOTE: The gravity activated valve is found in the fuel line between the fuel tank and carburetor.)

III. Methods of carburetor vapor control

A. Elimination of external carburetor vents

B. Use of insulating washers on carburetor hold-down studs

C. Use of insulating gaskets and aluminum heat shields between intake manifold and the carburetor

D. Venting of carburetor fuel bowls to the charcoal canister

INFORMATION SHEET

IV. Evaporative emissions control system operation

A. As the fuel becomes warm it expands and at the same time releases fuel vapors

B. The expansion is taken up in the design of the fuel tank which prevents filling approximately 11% of the tank's volume

C. The vapors that are released pass through the vent lines to the vapor liquid separator which allows the vapors to pass through but will prevent any liquid fuel from passing

D. The vapors travel to the activated charcoal canister where they are trapped and stored

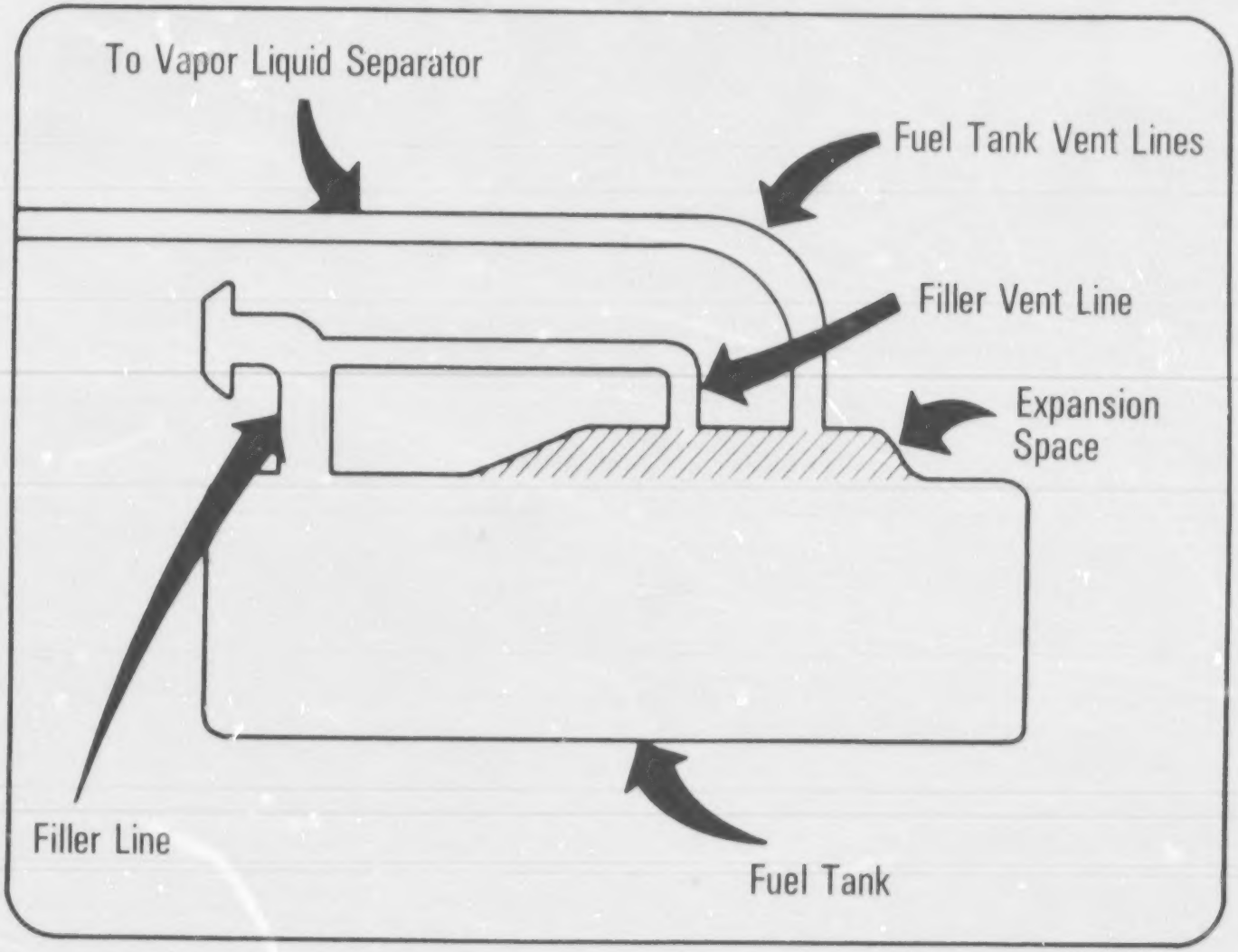
E. When the engine is started, the canister is purged via a purge line that runs to the carburetor or air cleaner

F. As fuel is consumed, a partial vacuum develops in the fuel tank

G. The filler cap acts as a fuel system relief valve to prevent damage to the fuel tank from excessive pressure or vacuum

(NOTE: Vacuum relief is provided after .25" Hg is reached and pressure relief is provided beyond .75 to 1.25 p.s.i.)

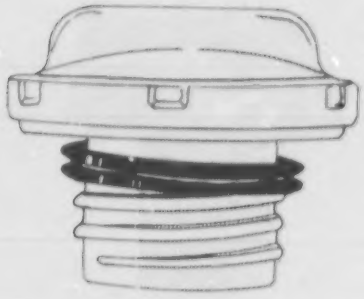
Fuel Tank With Thermal Expansion Volume



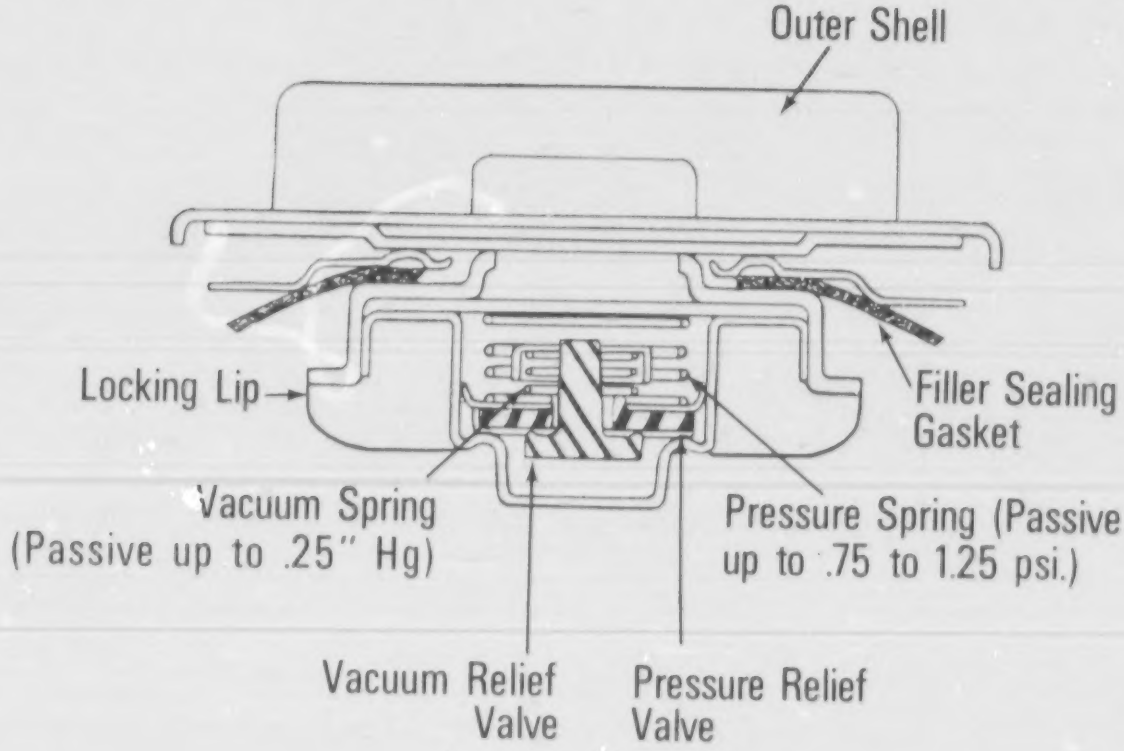
TM 1

AEC 85

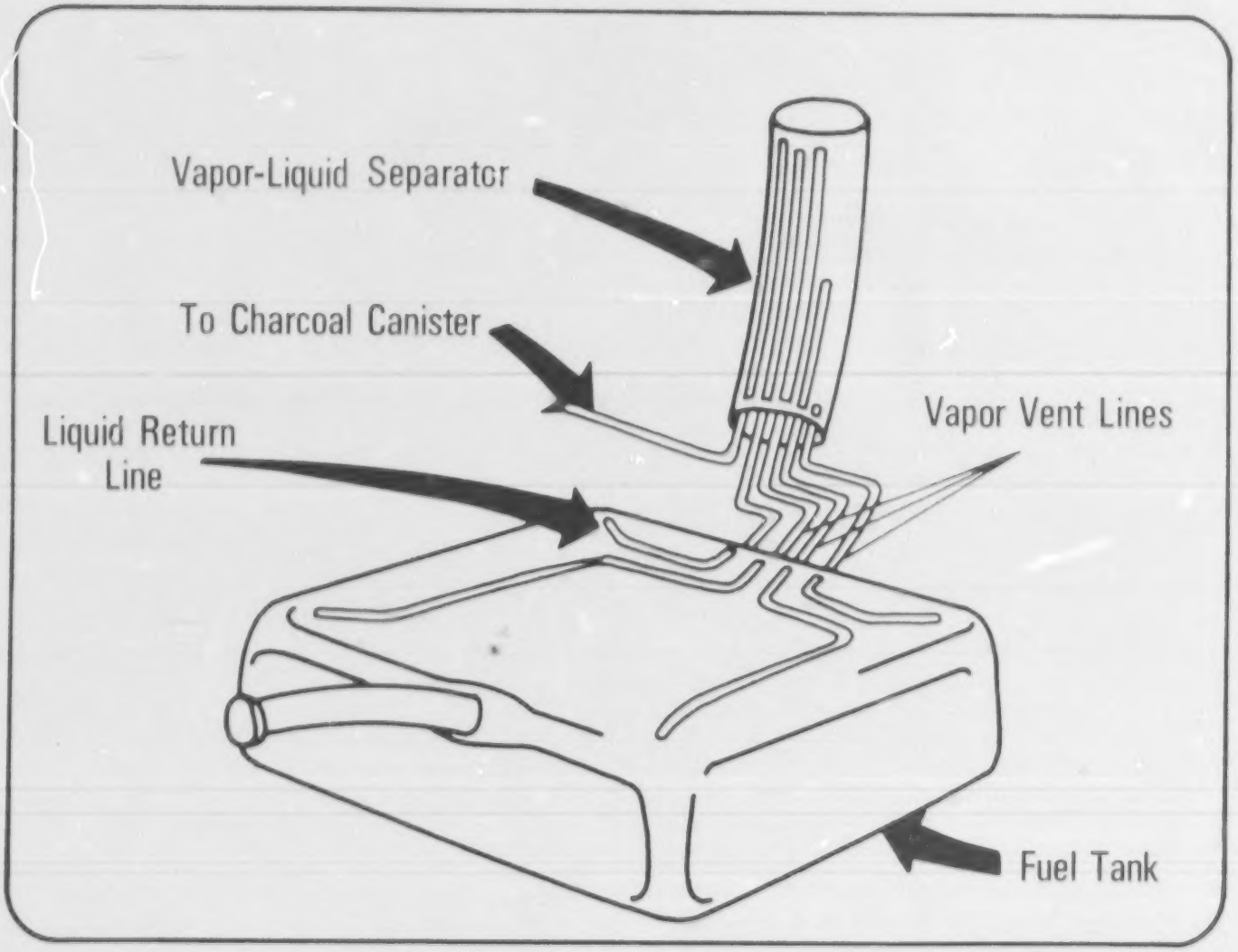
Pressure-Vacuum Relief Filler Cap



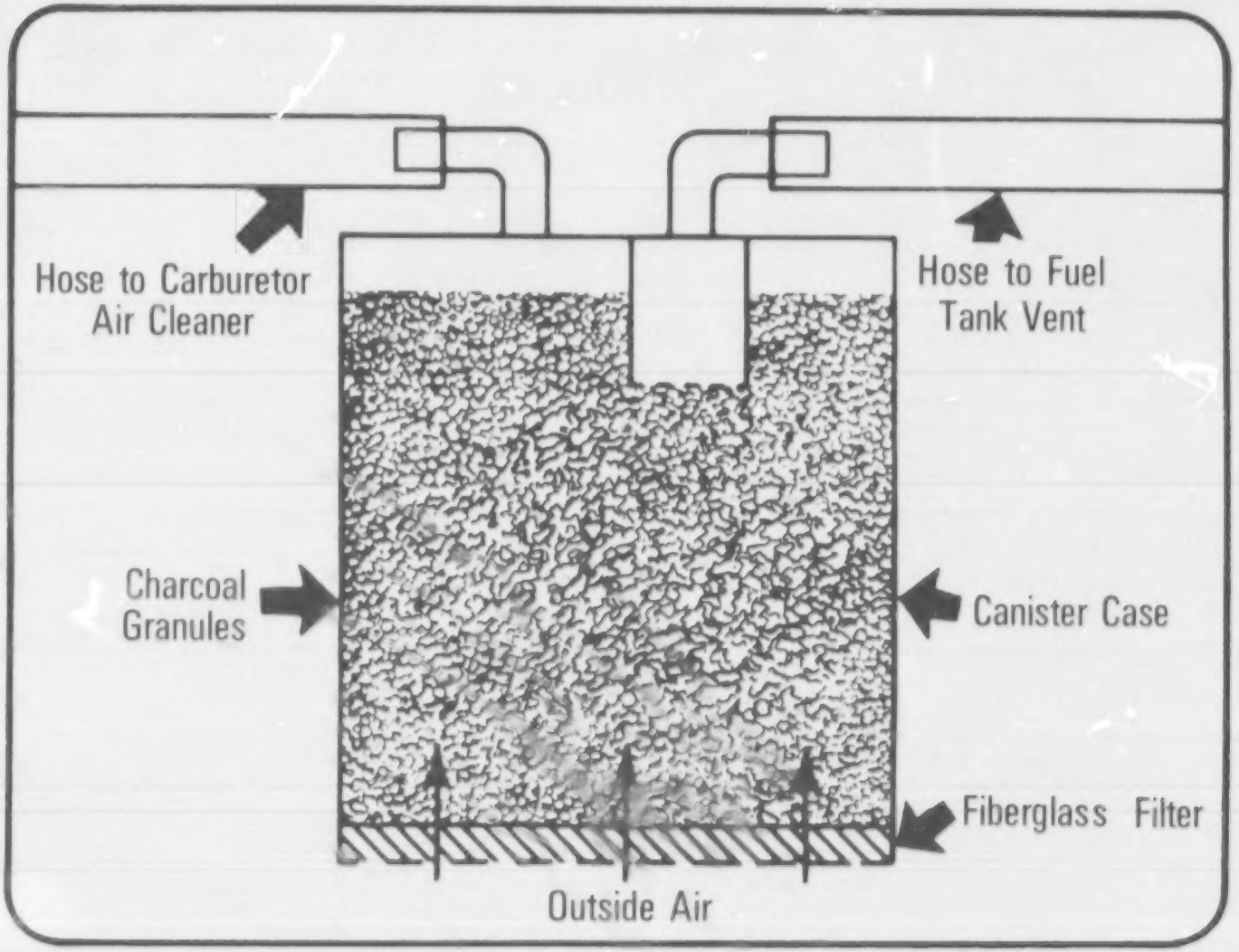
Screw-In Type


Outer Shell
Locking Lip
Filler Sealing Gasket
Vacuum Spring (Passive up to .25" Hg)
Pressure Spring (Passive up to .75 to 1.25 psi.)
Vacuum Relief Valve
Pressure Relief Valve

Vapor-Liquid Separator



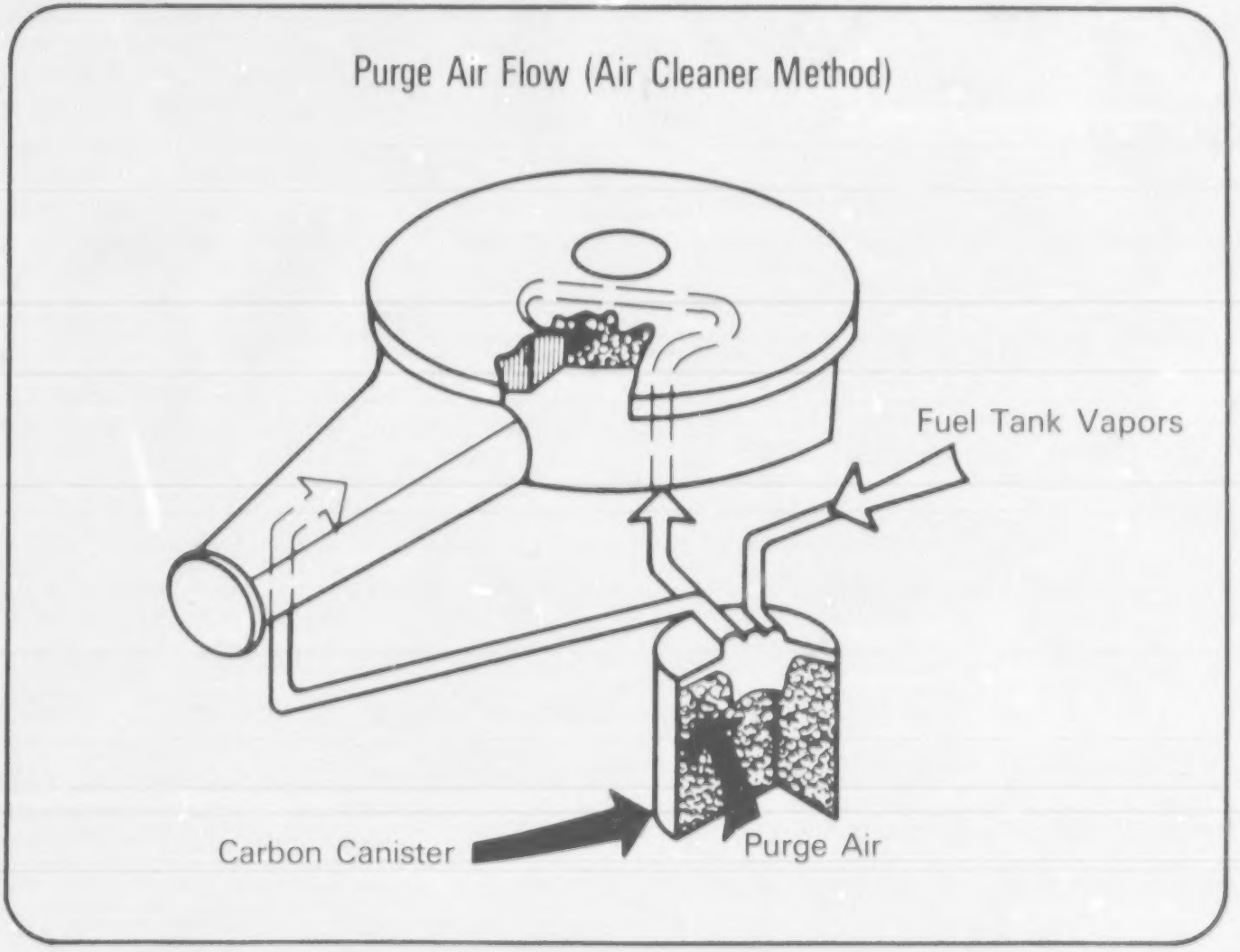
Charcoal Canister



TM 4

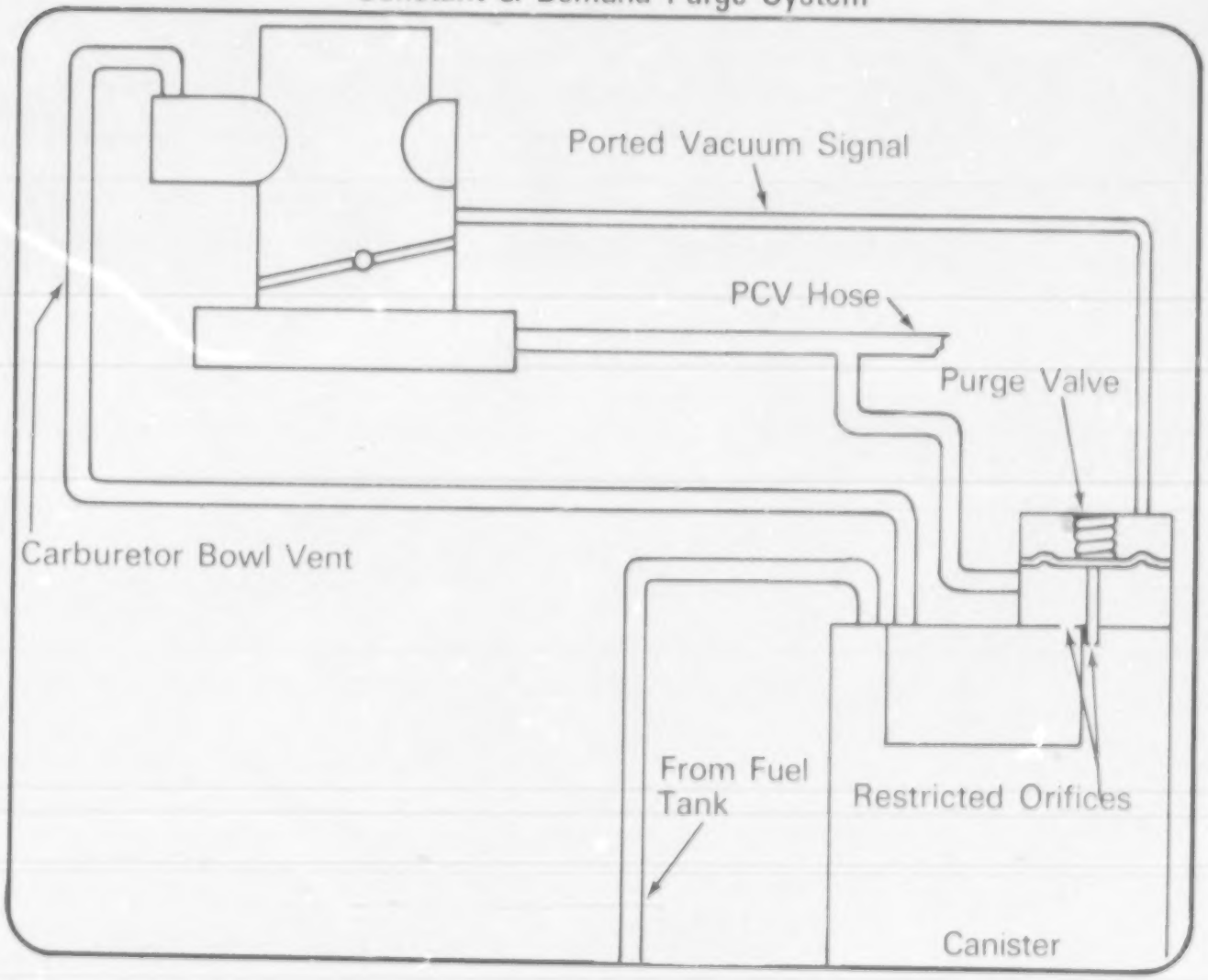
AEC 91

Charcoal Canister Purging Methods



Charcoal Canister Purging Methods (Continued)

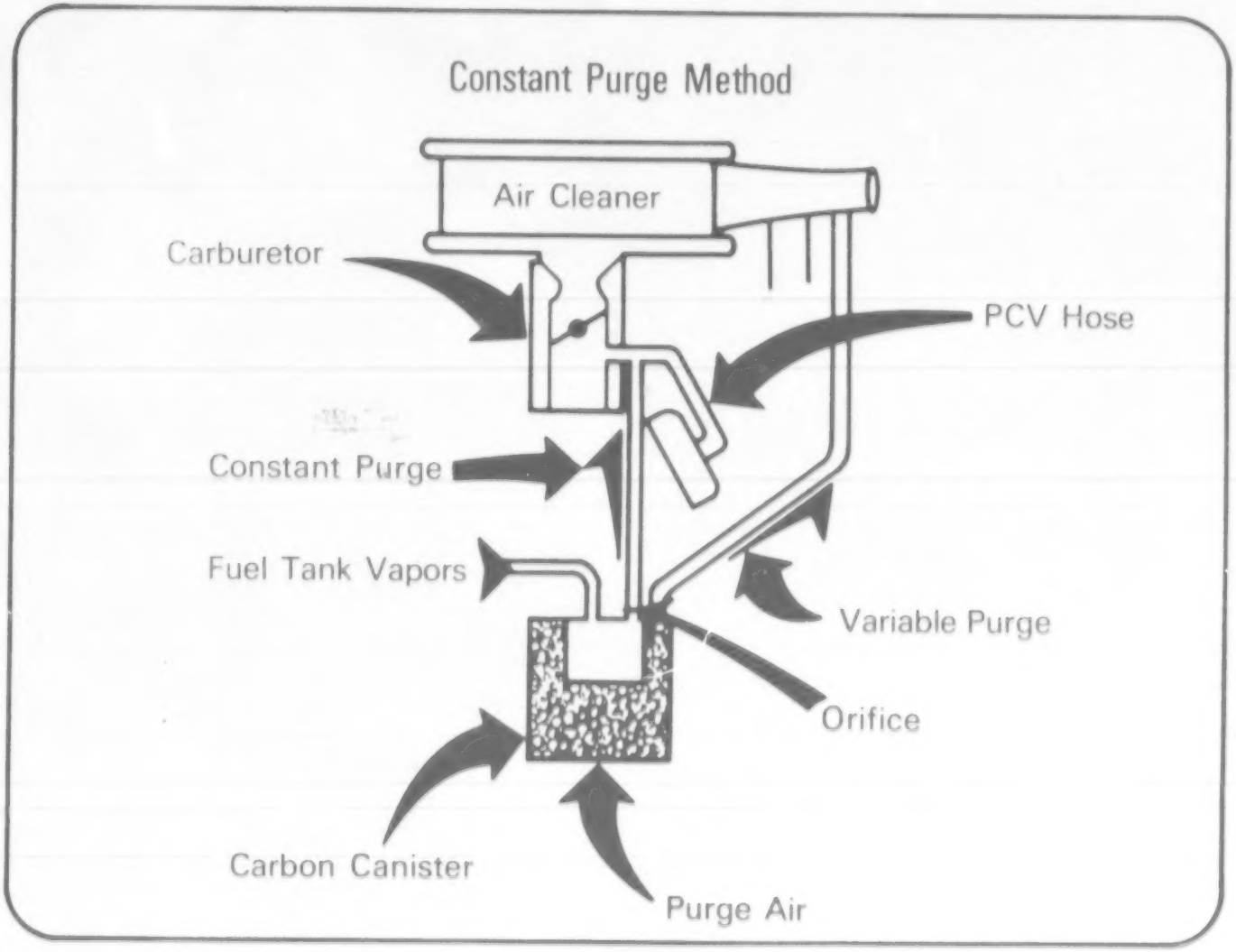
Constant & Demand Purge System



TM 6

AEC 95

Charcoal Canister Purging Methods (Continued)



EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

JOB SHEET #1-CHANGE THE CHARCOAL CANISTER FILTER

I. Tools required-Basic shop tools

II. Procedure

A. Disconnect hoses from top of canister

B. Remove canisters from mounting bracket

C. Remove cover from bottom of canister

D. Remove filter element

E. Install new filter element

F. Replace cover

G. Reinstall canister in mounting bracket

H. Reconnect hoses

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service shop manual or technical manual for exact procedures for each make and model.)

EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

JOB SHEET #2 TEST THE FUEL TANK FILLER CAP

I. Tools required None

II. Prccedure

A. Remove fuel tank filler cap

B. Apply oral vacuum and check that valve opens under vacuum and closes under pressure

C. If valve fails to open or close, replace the filler cap

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service shop manual or technical manual for exact procedures for each make and model.)

EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

NAME _____

TEST

1. Write the purpose of the evaporative emissions control system.

2. Match the components on the right to their functions.

_____a. Allow vapors to be directed from the fuel tank to a vapor-liquid separator and to the charcoal canister

_____b. Seals the fuel tank and acts as a relief valve to protect the fuel tank from excessive pressure or vacuum

_____c. A sealed unit for storing fuel that has a built in air space (approximately 11% of tank volume) to allow for fuel expansion due to temperature increases

_____d. Prevents passage of fuel to the carbon canister by means of either a float valve which seals off the line where fuel enters or by a series of standpipes

_____e. Prevents the spillage of fuel from the fuel system in the event of rollover of the automobile

_____f. Traps and stores fuel vapors by means of activated charcoal contained in a sealed unit

1. Charcoal canister
2. Rollover check valve
3. Vapor-liquid separator
4. Vapor vent lines
5. Fuel tank filler cap
6. Fuel tank

3. List four methods of carburetor vapor control.

a.

b.

c.

d.

4. Explain the operation of the evaporative emissions control system.

5. Demonstrate the ability to:

   a. Change the charcoal canister filter.

   b. Test the fuel tank filler cap.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

EVAPORATIVE EMISSIONS CONTROL SYSTEM
UNIT V

ANSWERS TO TEST

1. The evaporative emissions control system controls the release of hydrocarbons (HC) to the atmosphere that results from fuel vapors escaping from fuel tanks and carburetor vents

2. a. 4
   b. 5
   c. 6
   d. 3
   e. 2
   f. 1

3. a. Elimination of external carburetor vents
   b. Use of insulating washers on carburetor hold down studs
   c. Use of insulating gaskets and aluminum heat shields between intake manifold and the carburetor
   d. Venting of carburetor fuel bowls to the charcoal canister

4. Explanation should include:
   a. As the fuel becomes warm it expands and at the same time releases fuel vapors
   b. The expansion is taken up in the design of the fuel tank which prevents filling approximately 11% of the tank's volume
   c. The vapors that are released pass through the vent lines to the vapor-liquid separator which allows the vapors to pass through but will prevent any liquid from passing
   d. The vapors travel to the activated charcoal cannister where they are trapped and stored
   e. When the engine is started, the canister is purged via a purge line that runs to the carburetor or air cleaner
   f. As fuel is consumed, a partial vacuum develops in the fuel tank
   g. The filler cap acts as a fuel system relief valve to prevent damage to the fuel tank from excessive pressure or vacuum

5. Performance skills evaluated to the satisfaction of the instructor

ENGINE MODIFICATION
UNIT VI

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the engine modifications which reduce emissions. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write the purpose of engine modification.
2. Explain engine modifications and their effects on emissions.

ENGINE MODIFICATIONS
UNIT VI

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Intake Manifold Modifications

2. TM 2--Combustion Chamber Modifications

3. TM 3--Precombustion Chamber (Stratified Charge)

D. Test

E. Answers to test

II. References:

A. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Chrysler Corporation, 1978.

B. Gargano Promotions. *Vehicle Emission Control.* Detroit, Mich: Gargano Promotions, 1973.

C. Glenn, H. T. *Glenn's Emission Control Systems.* Chicago, Illinois: Henry Regnery Co., 1972.

D. Heinen, C. M. "We've Done the Job - What's Next?" *SAE Vehicle Emissions,* Part II, Vol. 14 P. T.

E. Heinen, N. A. and Patterson, D. J. *Emissions From Combustion Engines and Their Control.* Ann Arbor, Michigan: Ann Arbor Science Publications, Inc., 1972.

F. Springer, G. S. and Patterson, D. J. *Engine Emission Pollutant Formation and Measurement.* New York: Plenum Press, 1973.

G. Crouse, W. H. and Anglin, David L. *The Auto Book.* New York: McGraw-Hill, Inc, 1979.

ENGINE MODIFICATIONS
UNIT VI

INFORMATION SHEET

I. Purpose of engine modification--The purpose of engine modification is to achieve more complete combustion and reduce engine emissions

II. Engine modifications and their effects on emissions

A. Intake manifold (Transparency 1)

1. Modifications

a. Smoother interior surfaces

b. Better part match up

c. Crossover of exhaust gases

d. Uniform passage ports

e. Single plane design

2. Effect on emissions

a. All fuel mixtures are distributed more evenly

b. Provides for increased vaporization of the fuel

c. Results in more complete combustion of the fuel mixture

B. Controlled engine operating temperature

1. Modifications

a. Faster warm-up

b. More evenly controlled cylinder wall temperature

2. Effect on emissions--More complete combustion

C. Combustion chamber (Transparency 2)

1. Modifications

a. Smoother surfaces

b. Elimination of small gaps

c. Better fitting head gaskets

d. Specially designed quench areas

INFORMATION SHEET

2. Effect on emissions

   a. Even burning of the fuel mixture

   b. More complete combustion

D. Lower compression ratio

   1. Modification--Redesigned pistons and cylinder heads

   2. Effect on emissions

      a. Use of nonleaded fuel made possible the reduction of lead emissions

      b. Decreases combustion chamber temperature to lower NO_x emissions

      (NOTE: Lower compression ratios reduce emissions but also reduce engine performance and efficiency.)

E. Modified valve timing

   1. Modification--Specially designed camshafts

      (NOTE: These allow the intake and exhaust valves to remain open during a part of the time of exhaust and intake strokes to allow exhaust gases to mix with the fuel mixture.)

   2. Effect on emissions--Combustion temperature is reduced

      (NOTE: This results in reduced NO_x emissions.)

F. Precombustion chamber (Transparency 3)

   1. Modification--Stratified charge of fuel mixture is provided to the combustion chamber by a specially designed precombustion chamber

      (NOTE: A rich mixture of fuel is ignited and allowed to ignite a weaker mixture in the main combustion chamber.)

   2. Effect on emissions--Stratified or layered mixture burns more completely

      (NOTE: This results in a reduction of the level of emissions. A stratified mixture is different from an uneven mixture caused by improper intake air temperatures. The mixtures are even in air/fuel amounts but are in layers from richer to weaker, not uneven.)

INFORMATION SHEET

G. Redesigned cylinder heads

1. Modifications

a. Larger exhaust valves

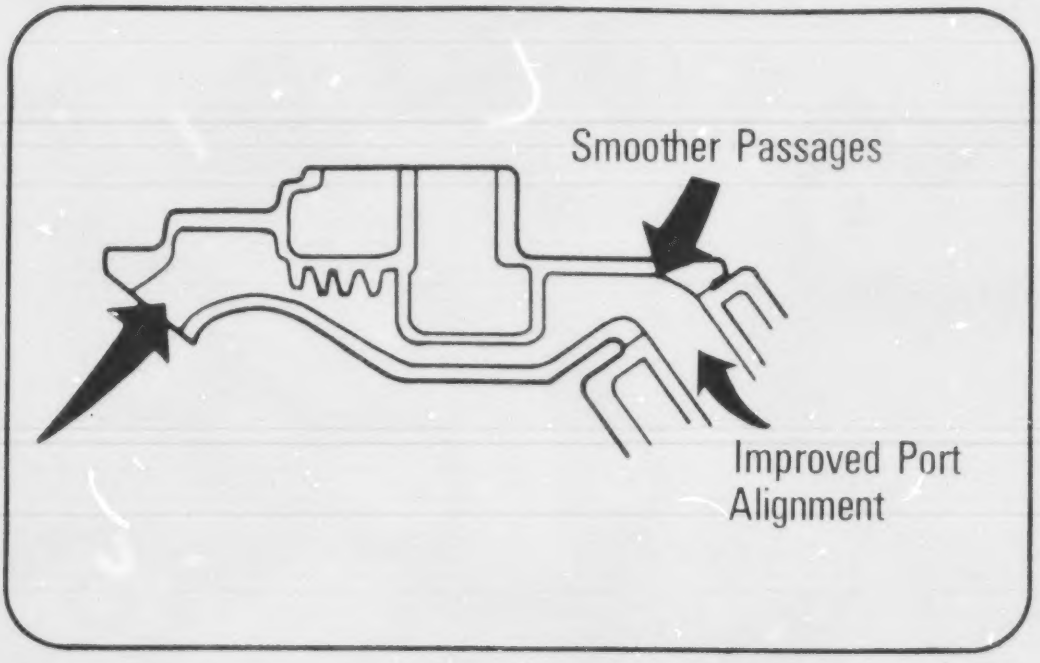
b. Air injection ports

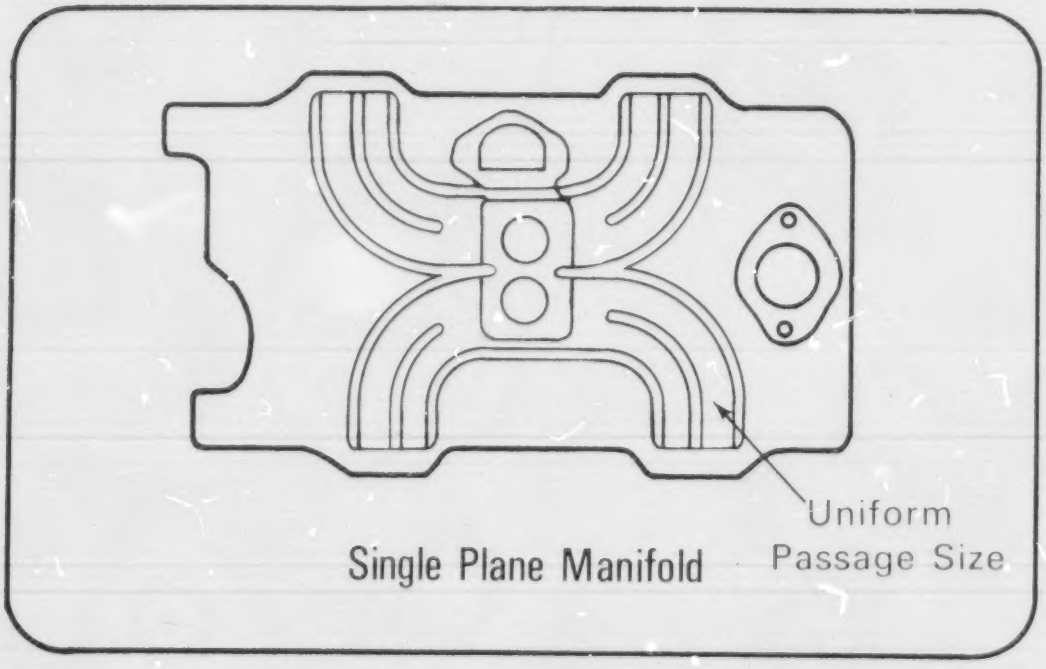
2. Effect on emissions

a. Dilution of fuel mixture by exhaust gases reduces combustion temperature and lowers NO_x emissions

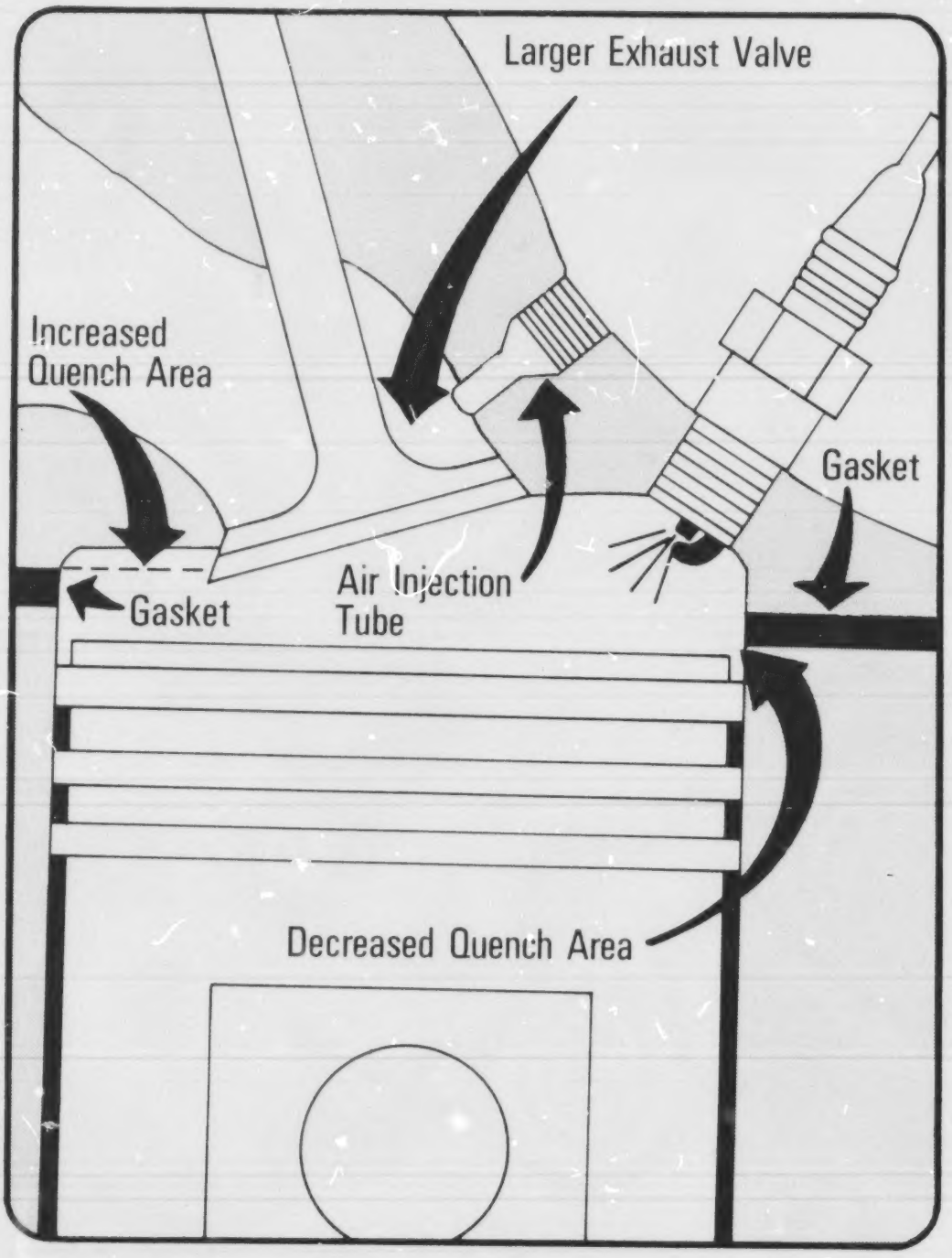
b. Promotes continued burning of hydrocarbons

Intake Manifold Modifications



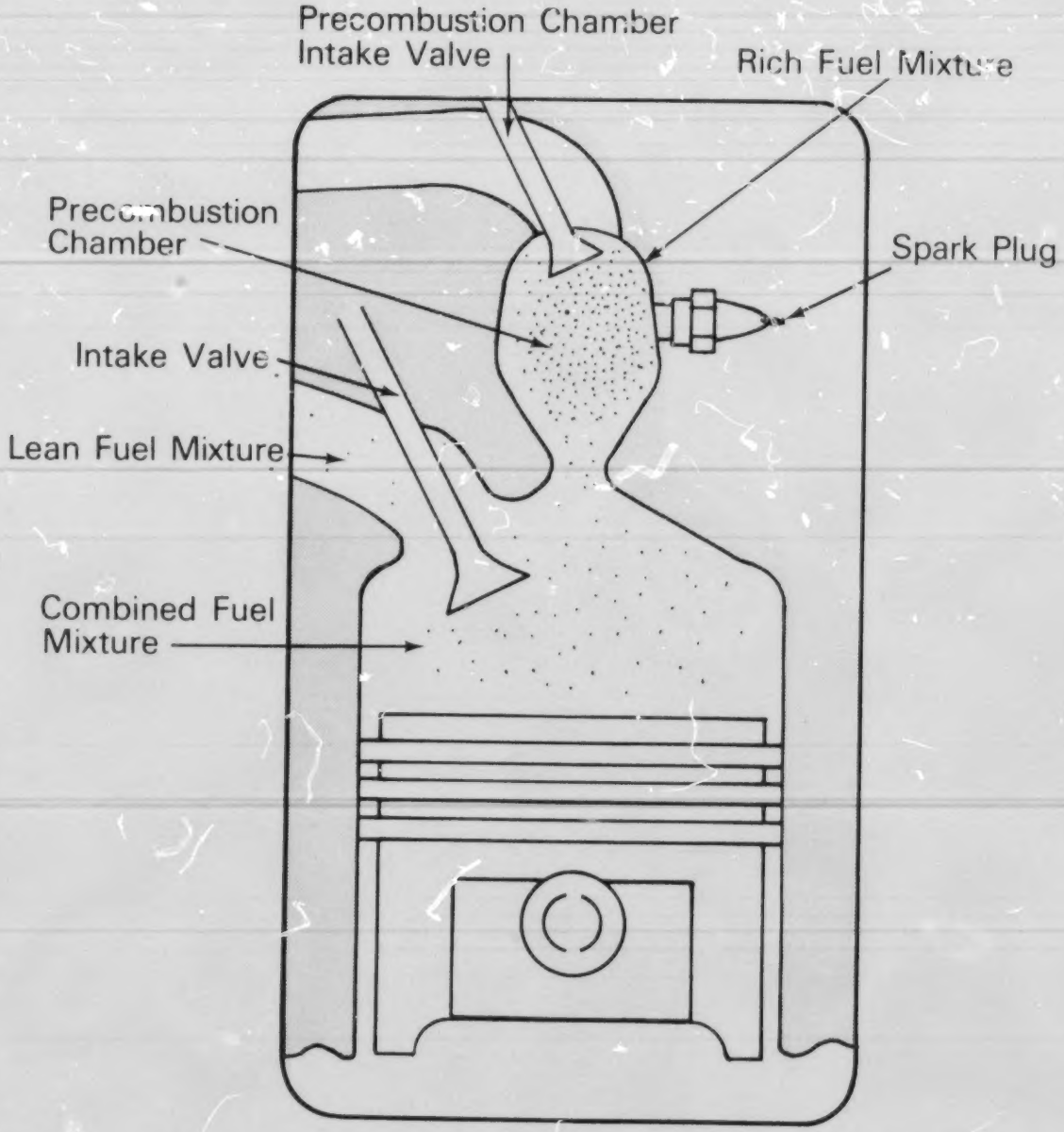


Combustion Chamber Modifications



Precombustion Chamber

(Stratified Charge)



ENGINE MODIFICATION
UNIT VI

NAME _____

TEST

1. Write the purpose of engine modification.

2. Explain engine modifications and their effects on emissions.

   a. Intake manifold

   b. Controlled engine operating temperature

   c. Combustion chamber

d. Lower compression ratio

e. Modified valve timing

f. Precombustion chamber

g. Redesigned cylinder heads

ENGINE MODIFICATION
UNIT VI

ANSWERS TO TEST

1. The purpose of engine modification is to achieve more complete combustion and reduce engine emissions

2. Explanation should include:

   a. Intake manifold

      1. Modifications

         a) Smoother interior surfaces

         b) Better part match up

         c) Crossover of exhaust gases

         d) Uniform passage ports

         e) Single plane design

      2. Effect on emissions

         a) All fuel mixtures are distributed more evenly

         b) Provides for increased vaporization of the fuel

         c) Results in more complete combustion of the fuel mixture

   b. Controlled engine operating temperature

      1. Modifications

         a) Faster warm-up

         b) More evenly controlled cylinder wall temperature

      2. Effect on emissions--More complete combustion

   c. Combustion chamber

      1. Modifications

         a) Smoother surfaces

         b) Elimination of small gaps

         c) Better fitting head gaskets

         d) Specially designed quench areas

2. Effect on emissions

a) Even burning of the fuel mixture

b) More complete combustion

d. Lower compression ratio

1. Modification--Redesigned pistons and cylinder heads

2. Effect on emissions

a) Use of nonleaded fuel made possible the reduction of lead emissions

b) Decreases combustion chamber temperature to lower NO_x emissions

e. Modified valve timing

1. Modification--Specially designed camshafts

2. Effect on emissions--Combustion temperature is reduced

f. Precombustion chamber

1. Modification--Stratified charge of fuel mixture is provided to the combustion chamber by a specially designed precombustion chamber

2. Effect on emissions--Stratified or layered mixture burns more completely

g. Redesigned cylinder heads

1. Modifications

a) Larger exhaust valves

b) Air injection ports

2. Effect on emissions

a) Dilution of fuel mixture by exhaust gases reduces combustion temperature and lowers NO_x emissions

b) Promotes continued burning of hydrocarbons

CARBURETOR MODIFICATIONS
UNIT V

UNIT OBJECTIVE

After completion of this unit, the student should be able to write the purpose of carburetor system modifications. The student should also be able to list the carburetor components which have been modified and match those modifications to their effects on the carburetor system. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write the purpose of carburetor system modification.
2. List four components which have been modified in the carburetor system.
3. Match the modification of the components to the effect of modification on the carburetor system.

CARBURETOR MODIFICATIONS
UNIT VII

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with information sheet.

B. Provide student with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Automatic Choke Assist Systems
2. TM 2--Staged Choke Pulldown
3. TM 3--Factory Set Idle Modifications
4. TM 4--Idle Adjustment Screw Limiters
5. TM 5--Other Idle Adjustment Modifications
6. TM 6--Idle-Stop Solenoid

7. TM 7--Other Carburetor Modifications

8. TM 8--Variable Venturi System

9. TM 9--Variable Fuel Jet System

D. Test

E. Answers to test

II. References:

A. *1979 Chryster-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Chrysler Corporation, 1978.

B. *Vehicle Emission Control.* Detroit, Mich.: Gargano Promotions, 1973.

C. Glenn, Harold T. *Glenn's Emission Control System.* Chicago, Ill.: Henry Regnery Co., 1972.

D. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

E. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1979.

F. Ford Motor Company. *Carburetor Service Manual.* Volume II. Detroit, Michigan: Service Publications/Helm, Inc., 1978.

G. General Motors Corporation. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

CARBURETOR MODIFICATIONS
UNIT VII

INFORMATION SHEET

I. Purpose of carburetor system modification--The purpose of carburetor system modification is to reduce the amount of hydrocarbon and carbon monoxide emissions released to the atmosphere during periods of engine idle, warm-up, and deceleration

(NOTE: Modifications have been made to reduce the richness of the air fuel mixture by diluting the mixture with additional air during idle. Also, during the warm up period, modifications to the automatic choke allow for faster opening of the choke to reduce the amount of rich fuel mixture used.)

II. Components modified in the carburetor system

A. Automatic choke system

B. Idle system

C. Fuel metering system

D. Venturi system

III. Effect on the carburetor system by modification of the components

(NOTE: A-C deal with modifications in the automatic choke system.)

A. Electrical element--Supplies additional heat to choke coil to reduce the time it would normally require to open (Transparency 1)

B. Stainless steel coil well--Provides faster transfer of heat to choke coil to reduce the amount of time engine heat is needed to open it (Transparency 1)

C. Two stage pulldown--Uses a temperature sensitive valve to control a vacuum assisted mechanism which opens the choke faster (Transparency 2)

(NOTE: The bimetal valve opens above 16°C [60°F] to provide manifold vacuum to a chamber in which a silicone fluid is contained. Atmospheric pressure forces the fluid through an orifice over a period of 20-30 seconds causing the choke to remain closed for only that length of time.)

(NOTE: D-H deal with modifications in the idle system.)

D. Internal idle control limiters--Prevents increasing idle adjustment richness beyond factory set limits (Transparency 3)

(NOTE: The internal idle limiters restrict mixture adjustments by limiting the amount of travel of the idle screw through a stoppage device or by idle needle limiters and restricted orifices.)

INFORMATION SHEET

E. External idle screw limiters--Plastic caps which reduce the amount of adjustment to approximately 3/4 of a turn to prevent setting the idle for an overrich mixture (Transparency 4)

D. Factory set off-idle air bleed screws--Reduce air fuel mixture richness (Transparency 5)

(NOTE: These are set by the factory using flow meters and are sealed so that adjustments are not possible.)

G. Carburetor dashpot--Holds the throttle plate open longer during deceleration to improve the combustion process by allowing more air to enter the carburetor (Transparency 5)

H. Idle-stop solenoid

1. Establishes a higher engine speed to improve combustion during deceleration

2. More completely closes the throttle plate to prevent dieseling or afterrun when engine is shut off

(NOTE: I-L deal with modifications in the fuel metering system.)

I. Adjustable part throttle (APT) screw--Provides more accurate fuel metering from fuel bowl to venturi assemblies

(NOTE: The APT metering rod is factory set using special fuel flow meters.)

J. Electronic fuel control (EFC)--Fuel flow and air mixture are metered by an electronically operated mixture control solenoid

(NOTE: The GM C-4 computerized carburetor system uses an oxygen sensor located in the exhaust manifold and a variable jet carburetor. The air/fuel mixture is regulated by a mixture control solenoid located in the fuel bowl which is attached to the fuel meter rod. The solenoid is controlled by an electronic control module which analyzes impulses from the oxygen sensor.)

K. Pull over enrichment fuel feed (POE)--Under conditions of high venturi vacuum, additional fuel is provided to the venturi to enrich the mixture under heavy engine loads (Transparency 7)

L. Variable fuel jet system (Vari-jet)--Fuel flow is metered to the venturi by means of electronic or vacuum linkage (Transparency 9)

(NOTE: A tapered moveable rod is controlled by either vacuum or electronic units to enlarge or decrease the size of the opening in the fuel jet allowing more or less fuel to enter as engine conditions indicate. Manifold vacuum or exhaust system oxygen monitors provide the sensing impulses to the control units on the carburetor. GM uses a computer regulated mixture control solenoid in the fuel bowl.)

INFORMATION SHEET

(NOTE: M and N deal with modifications in the venturi system.)

M. Triple venturi--The speed of air passing through the carburetor throat is increased three times to provide a more even and precise air-fuel mixture to the combustion chamber. (Transparency 7)

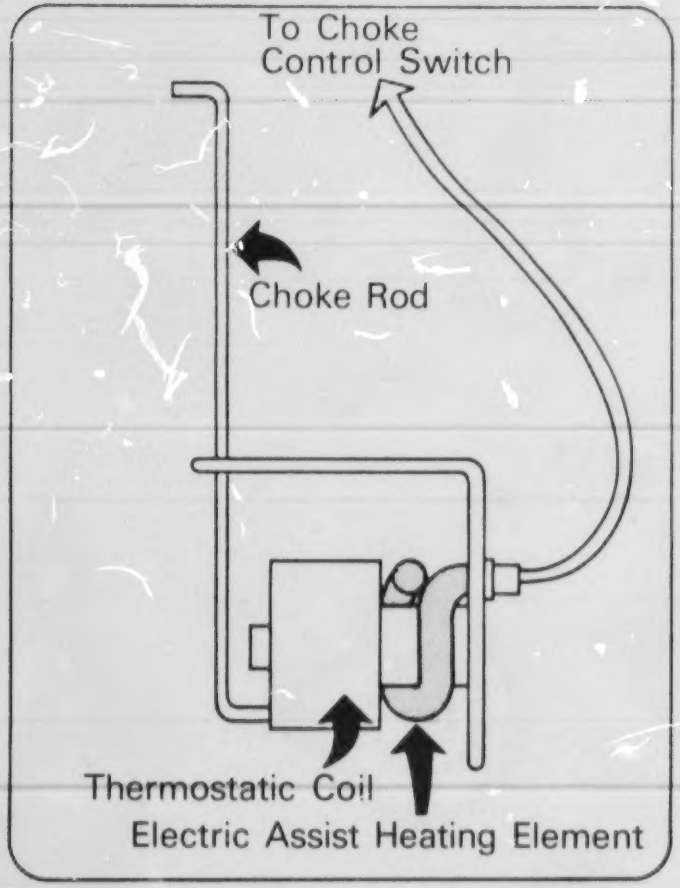
(NOTE: The three venturis are located side by side in the carburetor throat to increase the speed of the air flow which mixes the fuel mixture more evenly. The system also allows better control of the amount of air flow through the carburetor which is necessary with the new leaner mixtures currently used.)

N. Variable venturi (VV)--The size of the venturi opening is adjusted to allow more or less airflow by a sliding venturi valve actuated by either a vacuum or electronic control (Transparency 8)

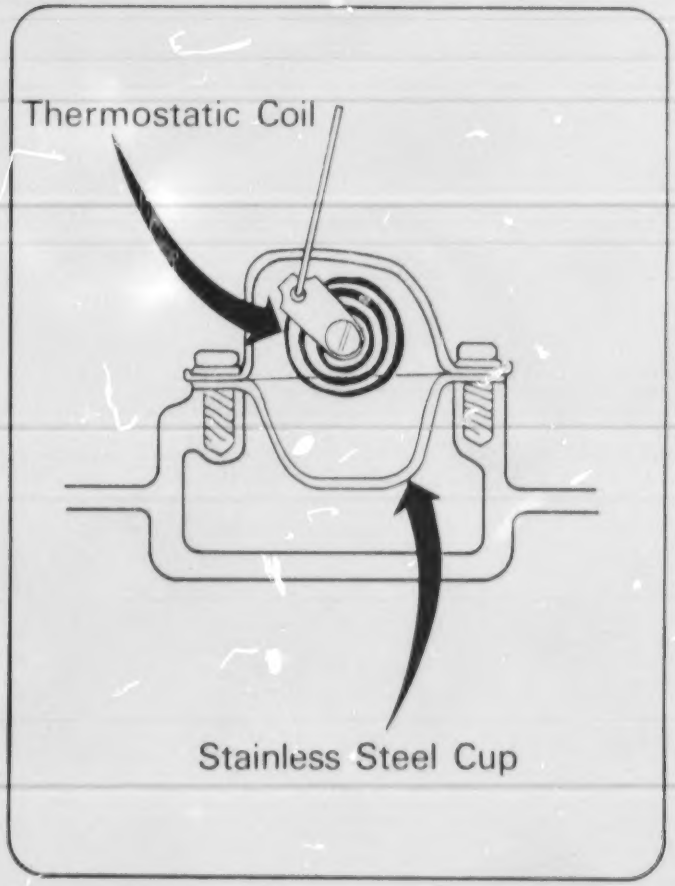
(NOTE: Some foreign manufacturers have used a round variable venturi for a while, but recently, Ford has introduced a rectangular venturi valve model which is electronically controlled. The electronic system uses an oxygen monitor in the exhaust manifold to determine engine fuel needs. An appropriate impulse is sent to the electric control unit (ECU) which analyzes the impulse and regulates a vacuum control unit on the carburetor which adjusts the venturi opening.)

Automatic Choke Assist Systems

Electric Choke System



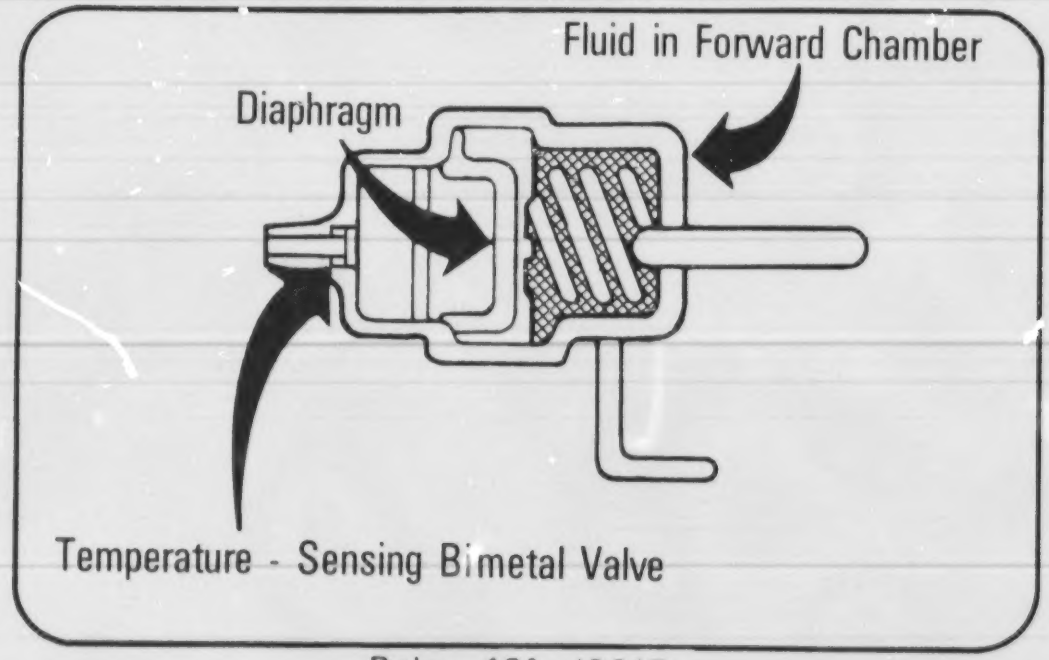
Stainless Steel Thermostatic Coil Well



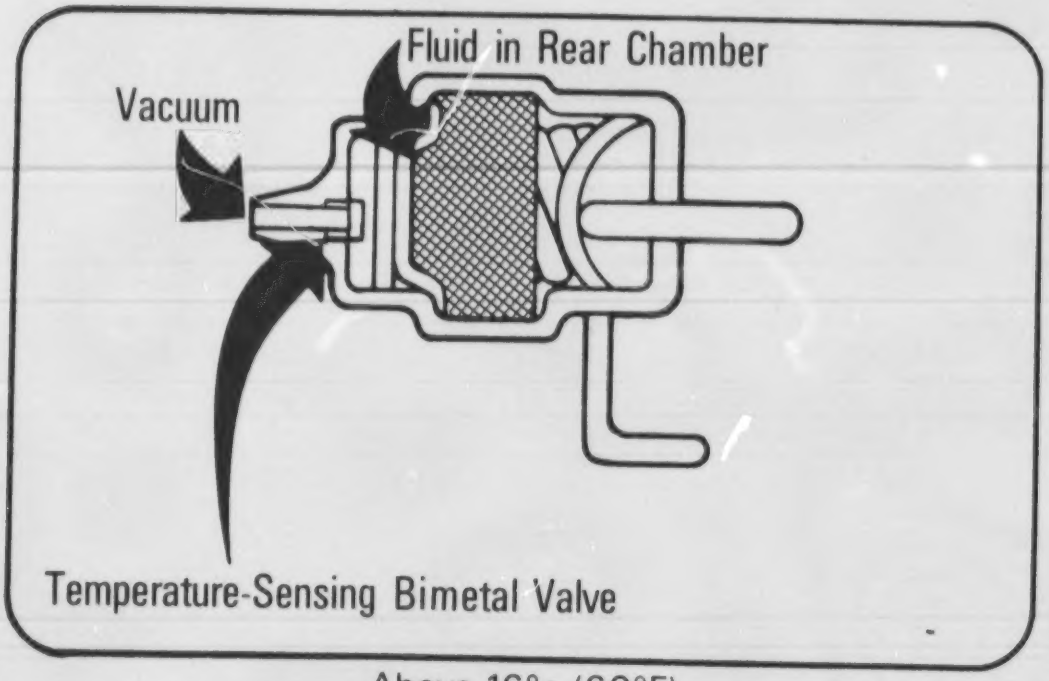
TM 2

AEC 133

Staged Choke Pulldown

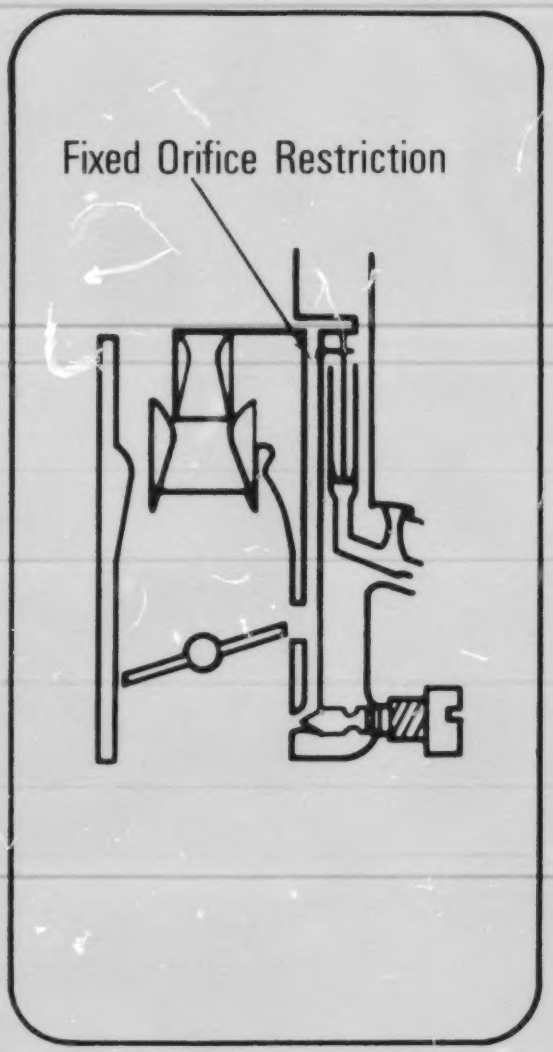


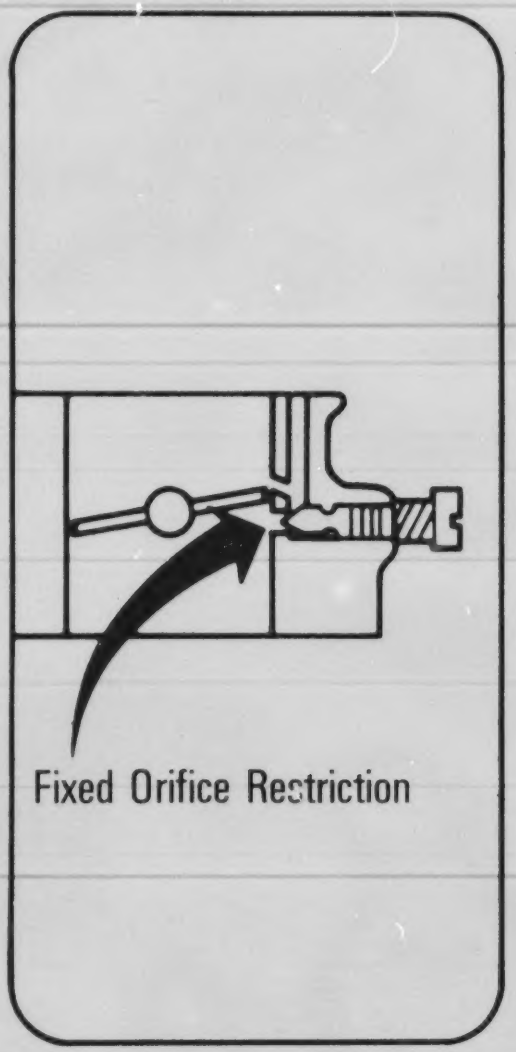
Below 16°c (60°F)

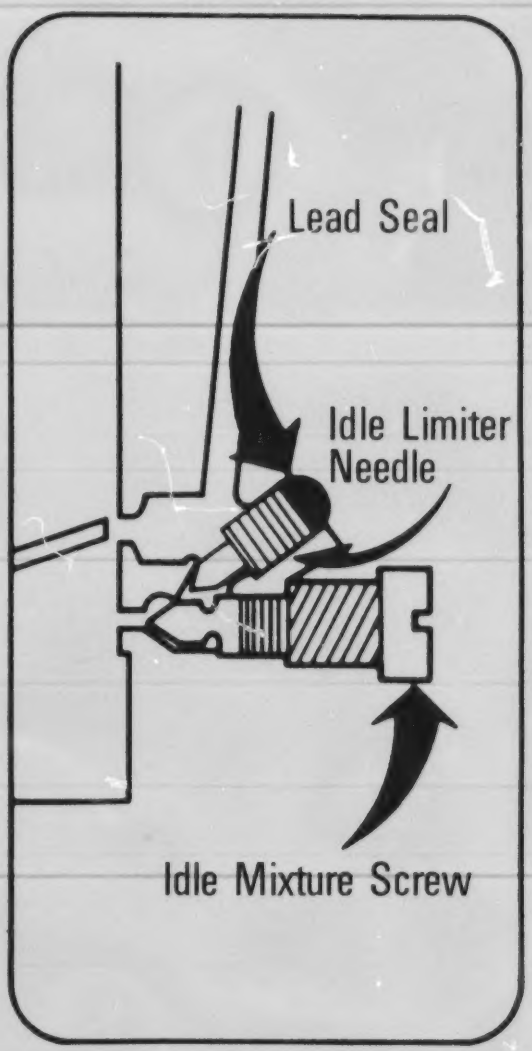


Above 16°c (60°F)

Factory Set Idle Modifications





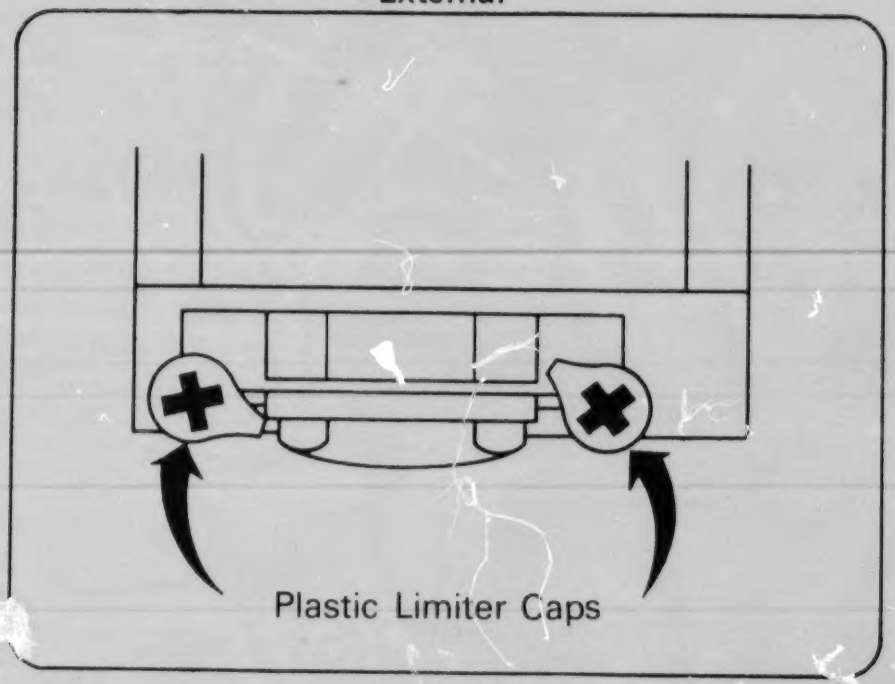


TM 3

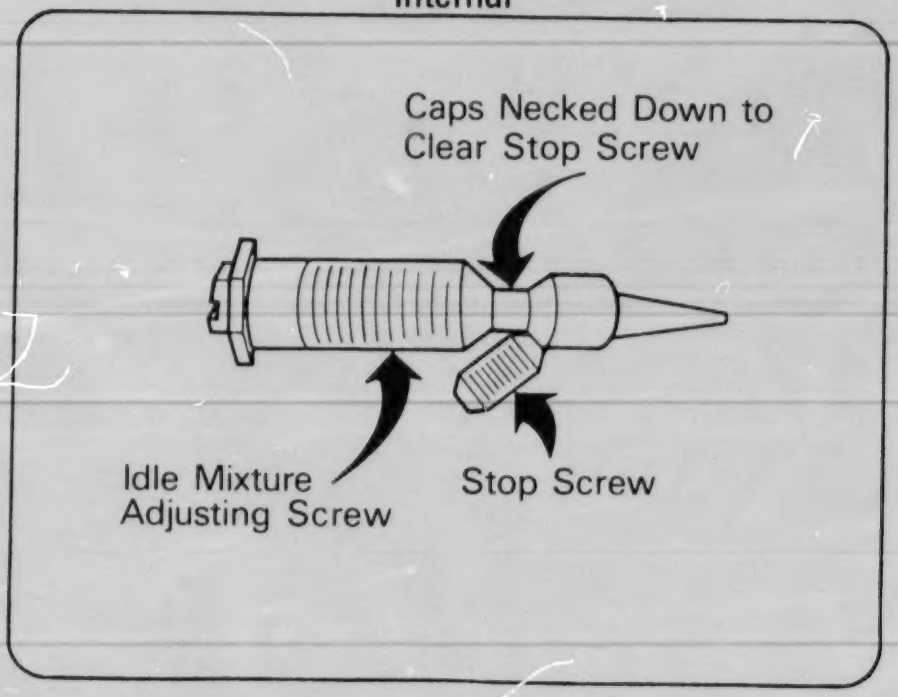
AEC 137

Idle Adjustment Screw Limiters

External



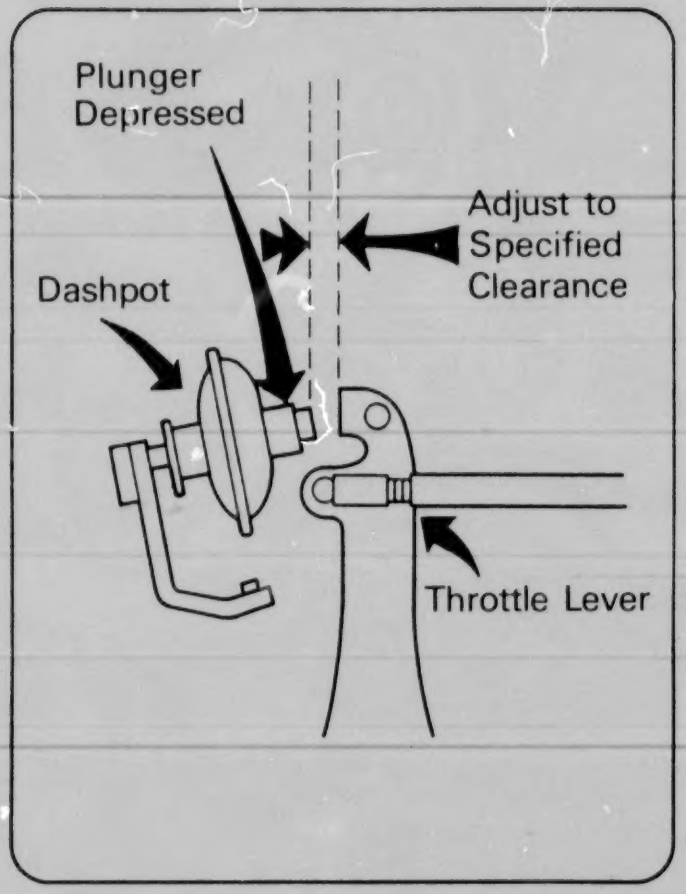
Internal



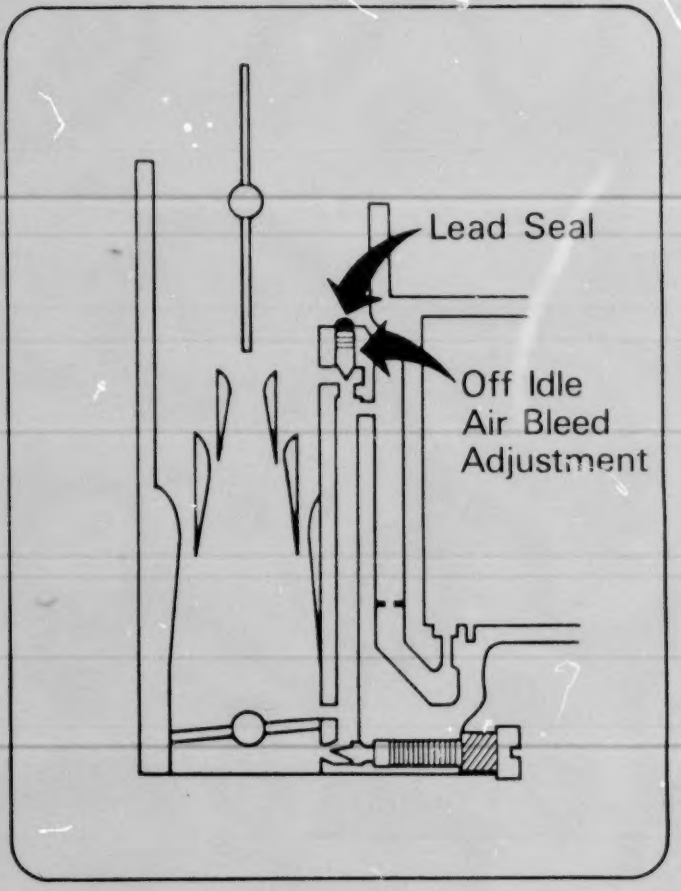
TM 4

Other Idle Adjustment Modifications

Carburetor Dashpot



Off Idle Air Bleed Adjusting Screw



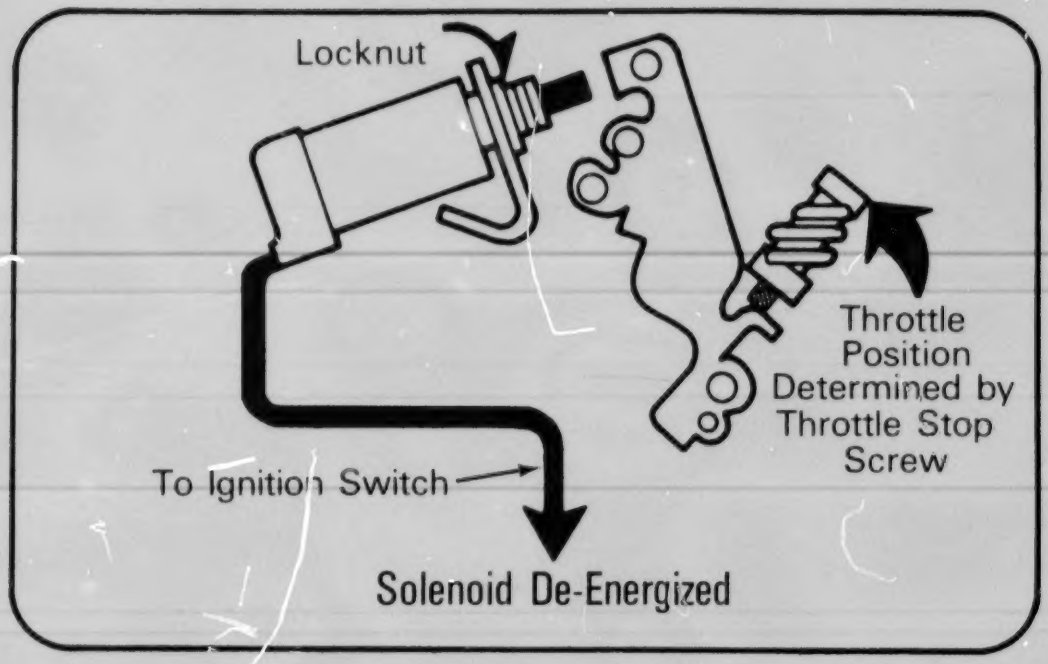
TM 5

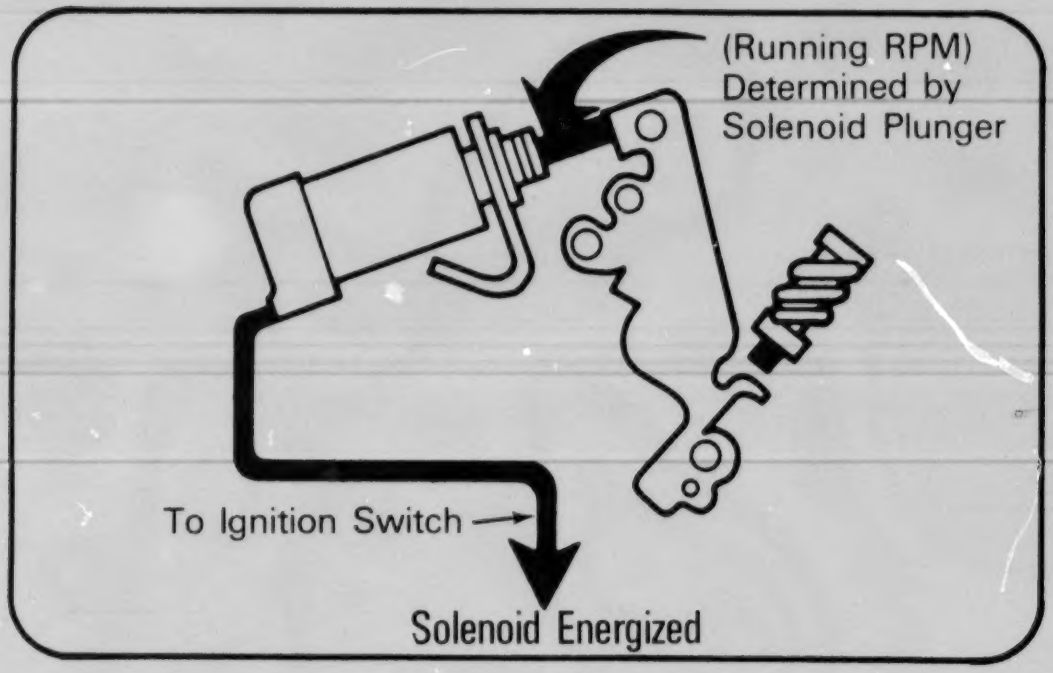
125

126

AEC 141

Idle-Stop Solenoid

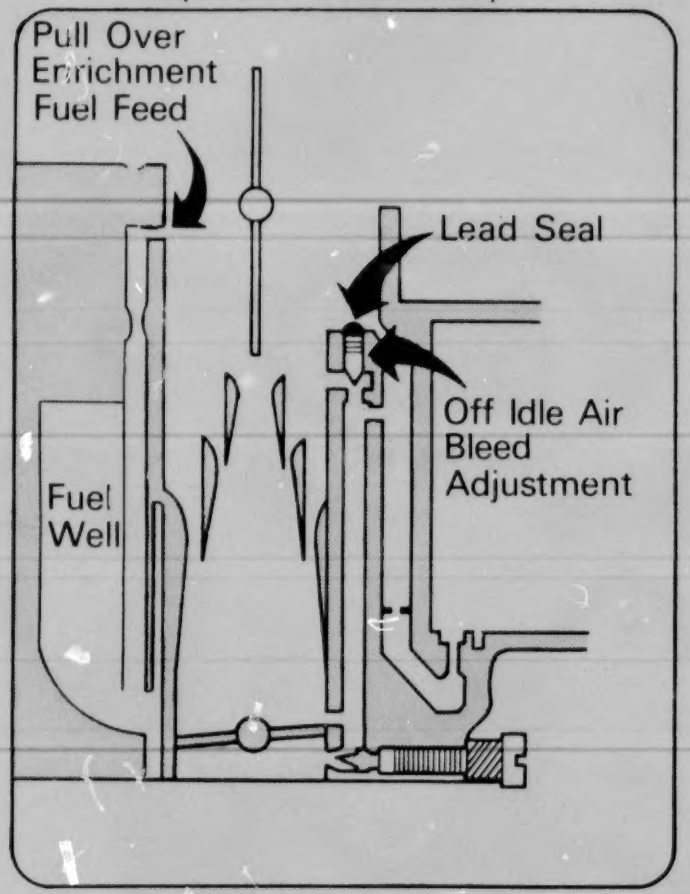




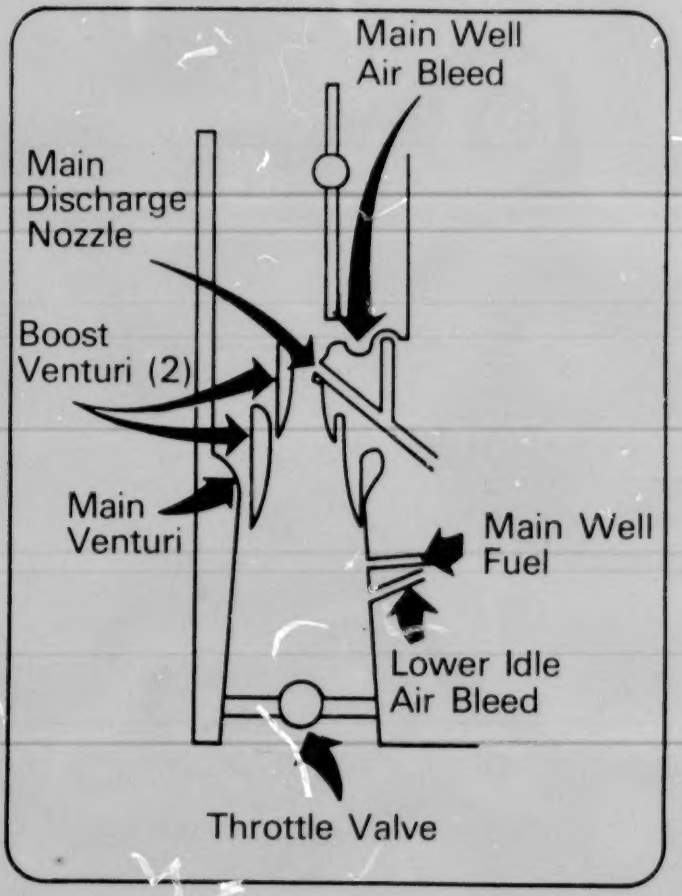
Other Carburetor Modifications

Pull

(Power Enrichment)



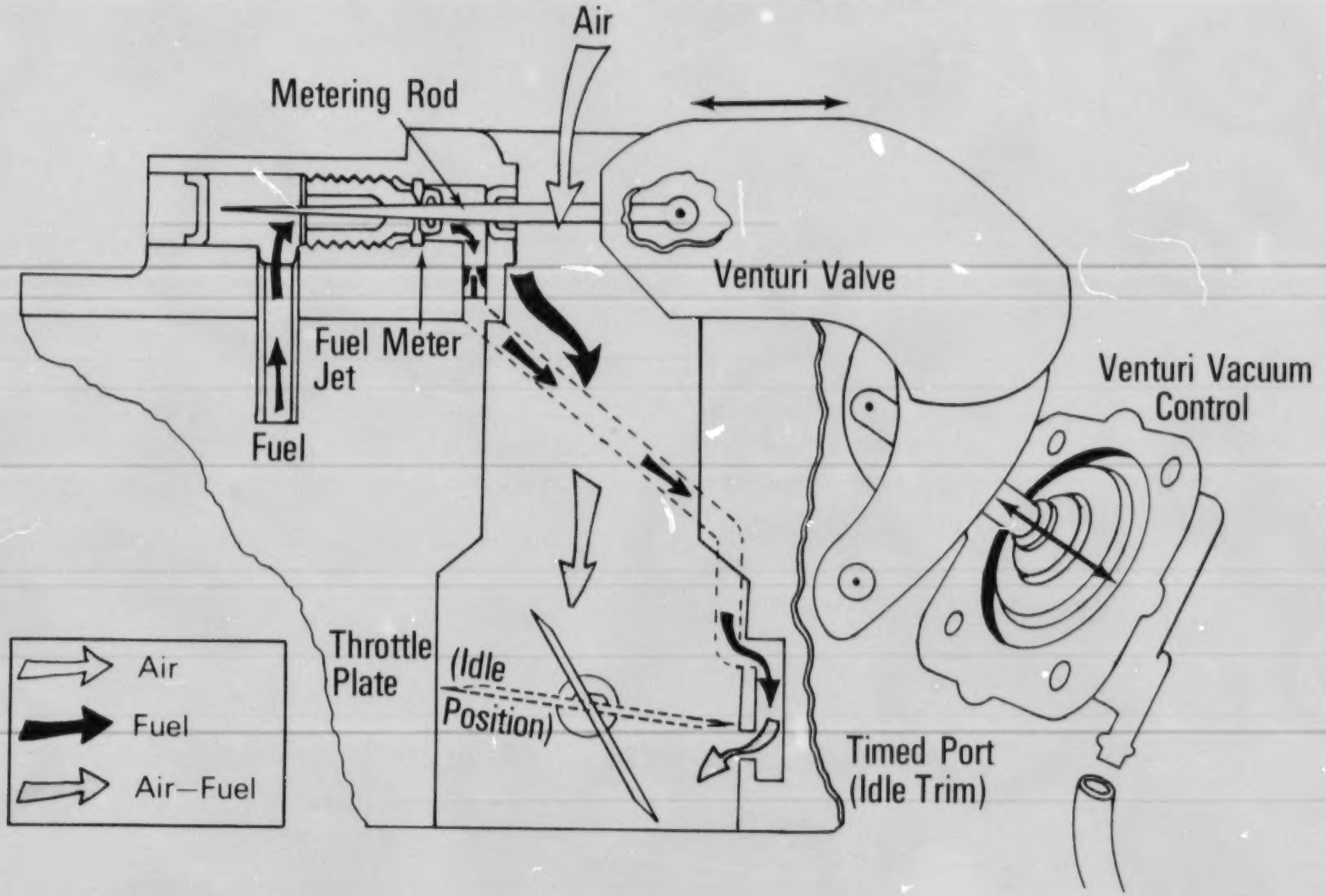
Triple Venturi



TM 7

AEC 145

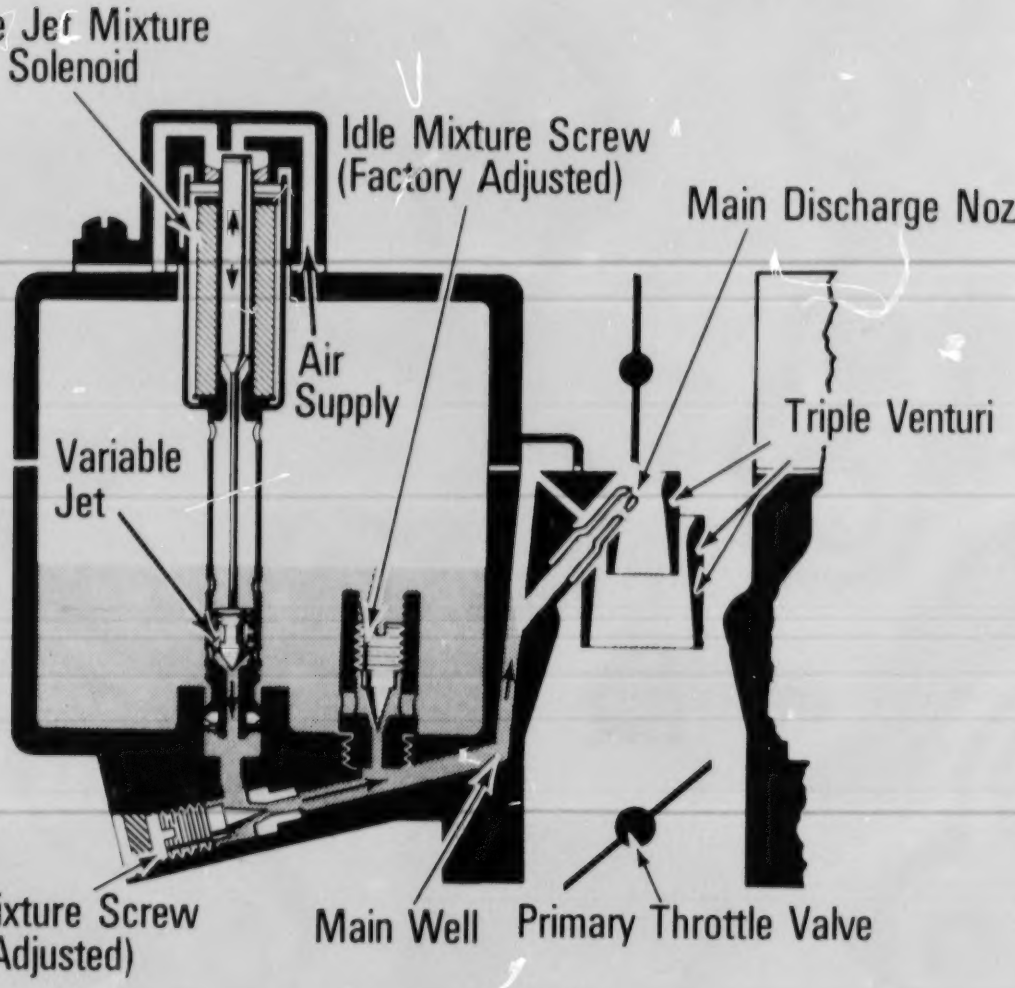
Variable Venturi System



TM 8

AEC 147

Variable Fuel Jet System



TM 9

AEC 149

CARBURETOR MODIFICATION
UNIT VII

NAME _____

TEST

1. Write the purpose of carburetor system modification.

2. List four components which have been modified in the carburetor system.

   a.

   b.

   c.

   d.

3. Match the modification of the components on the right to the effect of modification on the carburetor system

_____a.	Uses a temperature sensitive valve to control a vacuum assisted mechanism which opens the choke faster	1. Electronic fuel control (EFC)
_____b.	Fuel flow and air mixture are metered by an electronically operated mixture control solenoid	2. Internal idle control limiters
_____c.	The size of the venturi opening is adjusted to allow more or less airflow by a sliding venturi valve actuated by either a vacuum or electronic control	3. Electrical element
_____d.	Supplies additional heat to choke coil to reduce the time it would normally require to open	4. External idle screw limiters
_____e.	Reduce air fuel mixture richness	5. Carburetor dashpot
_____f.	Provides faster transfer of heat to choke coil to reduce the amount of time engine heat is needed to open it	6. Two-stage pulldown
_____g.	Prevents increasing idle adjustment richness beyond factory set limits	7. Adjustable part throttle (APT) screw
_____h.	Plastic caps which reduce the amount of adjustment to approximately 3/4 of a turn to prevent setting the idle for an overrich mixture	8. Stainless steel coil well

_____i. Holds the throttle plate open longer during deceleration to improve the combustion process by allowing more air to enter the carburetor

_____j. Provides more accurate fuel metering from fuel bowl to venturi assemblies

_____k. Under conditions of high venturi vacuum, additional fuel is provided to the venturi to enrich the mixture under heavy engine loads

_____l. Fuel flow is metered to the venturi by means of electronic or vacuum linkage

_____m. The speed of air passing through the carburetor throat is increased three times to provide a more even and precise air-fuel mixture to the combustion chamber

_____n. a. Establishes a higher engine speed to improve combustion during deceleration

b. More completely closes the throttle plate to prevent dieseling or after-run when engine is shut off

9. Pull over enrichment fuel feed

10. Triple venturi

11. Variable fuel jet system (Vari-jet)

12. Variable venturi (VV)

13. Idle-stop solenoid

14. Factory set off-idle air-bleed screws

CARBURETOR MODIFICATIONS
UNIT VII

ANSWERS TO TEST

1. The purpose of carburetor system modification is to reduce the amount of hydrocarbon and carbon monoxide emissions released to the atmosphere during periods of engine idle, warm-up, and deceleration

2. a. Automatic choke system

   b. Idle system

   c. Fuel metering system

   d. Venturi system

3. a. 6

   b. 1

   c. 12

   d. 3

   e. 14

   f. 8

   g. 2

   h. 4

   i. 5

   j. 7

   k. 9

   l. 11

   m. 10

   n. 13

IGNITION TIMING SYSTEM
UNIT VIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to state the purpose of the ignition timing system and explain the operation of the components of the system. The student should also be able to demonstrate the ability to visually inspect, test and service the components. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the components of the ignition timing system to their correct functions.
2. State the purpose of the ignition timing system.
3. Describe the operation of the thermostatic vacuum switch.
4. Describe the operation of the dual diaphragm vacuum advance unit.
5. Explain the operation of the cold start spark advance (CSSA) system.
6. Demonstrate the ability to:
   a. Test for proper operation of the thermostatic vacuum switch.
   b. Test for proper operation of the vacuum advance unit.

IGNITION TIMING SYSTEM
UNIT VIII

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Thermostatic Vacuum Switch (TVS/PVS)
2. TM 2--Carburetor Vacuum Advance Port
3. TM 3--Thermostatic Vacuum Switch Operation
4. TM 4--Dual Diaphragm Vacuum Advance Unit and Operation
5. TM 5--Spark Control Operation Using Multiple TVS/PVS Valves

D. Job sheets

1. Job Sheet #1--Test for Proper Operation of the Thermostatic Vacuum Switch

2. Job Sheet #2--Test for Proper Operation of the Vacuum Advance Unit

E. Test

F. Answers to test

II. References:

A. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

B. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/ General Motors Corporation, 1979.

C. Ford Motor Company. *Vehicle Emission Control Systems.* Detroit, Michigan: Service Publications/Helm, Inc., 1978.

D. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

E. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Chrysler Corporation, 1978.

IGNITION TIMING SYSTEM
UNIT VIII

INFORMATION SHEET

I. Components and functions

A. Thermostatic vacuum switch (TVS/PVS)--A temperature sensitive valve which regulates vacuum from carburetor or manifold ports to vacuum advance unit according to engine coolant temperature (Transparency 1)

(NOTE: The various manufacturers use a temperature sensitive valve and control vacuum source. Each manufacturer may refer to the switch by different names but the function is the same for all. They generally contain a heat expandable substance like copper oxide paste.)

B. Dual diaphragm vacuum advance unit--A vacuum regulated device on the distributor that advances engine timing on impulse from the carburetor port or retards timing when a signal is received from the manifold port

C. Orifice spark advance control (OSAC)--A single function valve which restricts vacuum advance to the distributor during rapid acceleration but does not cut off vacuum on deceleration

(NOTE: Chrysler uses this method of spark control. It is a one-way control and does not provide spark retard on deceleration.)

D. Spark delay valve (SDV)--A dual function valve which delays or restricts vacuum advance during rapid acceleration and cuts off vacuum advance on deceleration

E. Coolant temperature override valve (CTO)--A temperature sensitive valve which directs vacuum advance during conditions of engine overheating

(NOTE: This valve is a TVS/PVS type valve that allows a vacuum signal to pass through when engine temperatures rise above 235°F. General Motors refers to it as a CTO, Chrysler calls it a TIC [Thermostatic Ignition Control Valve], and Ford calls it a PVS.)

F. Distributor retard control valve (DRCV)--A control valve which restricts spark retardation signals to the distributor during conditions of cold engine temperatures

G. Vacuum port--An opening above the carburetor throttle plate which provides carburetor vacuum when the throttle plate is opened (Transparency 2)

INFORMATION SHEET

II. Purpose of the ignition timing system--The purpose of the ignition timing system is to regulate the timing of an automobile engine to provide more effective emission control during conditions of engine idle and deceleration

(NOTE: Emissions are highest during idle conditions. To reduce emissions, the spark is retarded and idle speed increased which allows greater air volume to dilute the fuel mixture and improve combustion. The retard is approximately an additional 12° from normal retard of 6°.)

III. Operation of thermostatic vacuum switch (TVS) (Transparency 3)

(NOTE: The operation of the TVS is similar to any of the following valves commonly used by the auto industry: PVS, CTO, TIC. Some manufacturers use a solenoid to control vacuum under normal conditions but rely on a TVS combination valve to direct vacuum when the engine overheats.)

A. Engine temperature is sensed by the TVS probe in the engine coolant

B. Under normal conditions the check ball is in a down position

C. Vacuum is directed from carburetor port to distributor vacuum advance unit

D. When engine temperature rises above 210° the check ball is forced upward

(NOTE: The copper oxide paste expands when heated and pushes the check ball upward against the normal spring tension. Temperatures vary with application.)

E. Vacuum from carburetor port is cut off

F. Vacuum is directed from the manifold port to the distributor

(NOTE: Prolonged idle can cause overheating. To reduce engine temperature a higher idle speed is provided by causing manifold vacuum to advance timing. Engine speed increase promotes cooling by the fan.)

G. A decrease in engine temperature allows the check ball to return to normal position

IV. Operation of the dual diaphragm vacuum advance unit (Transparency 4)

A. Vacuum signals are received from the carburetor port or intake manifold port

B. The outer diaphragm operates on carburetor vacuum to advance timing

(NOTE: The outer diaphragm is the advance diaphragm. It is larger and, therefore, can override the smaller unit with less signal.)

INFORMATION SHEET

C. The inner (retard) diaphragm operates on manifold vacuum

(NOTE: Manifold vacuum is stronger at idle and during deceleration than carburetor vacuum so the timing is retarded under these conditions.)

D. Calibrated springs center the diaphragm under low vacuum conditions

E. The advance diaphragm is connected to the breaker plate of the distributor

F. Movement of the diaphragms increases or decreases spark timing as the breaker plate moves with or against the distributor rotation

G. Under overheat or cold start conditions, manifold vacuum is provided to the advance diaphragm to provide needed timing increases

(NOTE: Vacuum signal is directed to the distributor by the TVS. The same signal is received by both diaphragms but the advance unit is larger and can overcome the smaller one to increase or advance the timing.)

H. Under deceleration conditions the weak carburetor signal to the advance diaphragm is overcome by the retard diaphragm because of a strong manifold vacuum supply and spark timing is retarded

(NOTE: The retard vacuum signal is momentarily delayed on deceleration in some applications but most use a spark delay valve which cuts off advance immediately on deceleration. New methods provide for continued combustion through air injection systems so a deceleration valve is not needed in timing systems.)

V. Cold start spark advance (CSSA) operation (Transparency 5)

(NOTE: To promote driveability during conditions of cold engine temperatures [below 125°F] a cold start system is used. This description is of a Ford system. Other manufacturers are similar or use ambient temperature switches in place of a second PVS.)

A. The system consists of two PVS controls with different temperature ranges (main PVS and CSSA PVS)

B. Under normal conditions, the main PVS directs carburetor vacuum signals to the distributor

C. During cold start conditions the CSSA PVS:

1. Cuts off carburetor vacuum from main PVS

2. Provides manifold vacuum through DRCV to distributor

INFORMATION SHEET

D. Above 125°F the CSSA PVS:

   1. Cuts off manifold vacuum

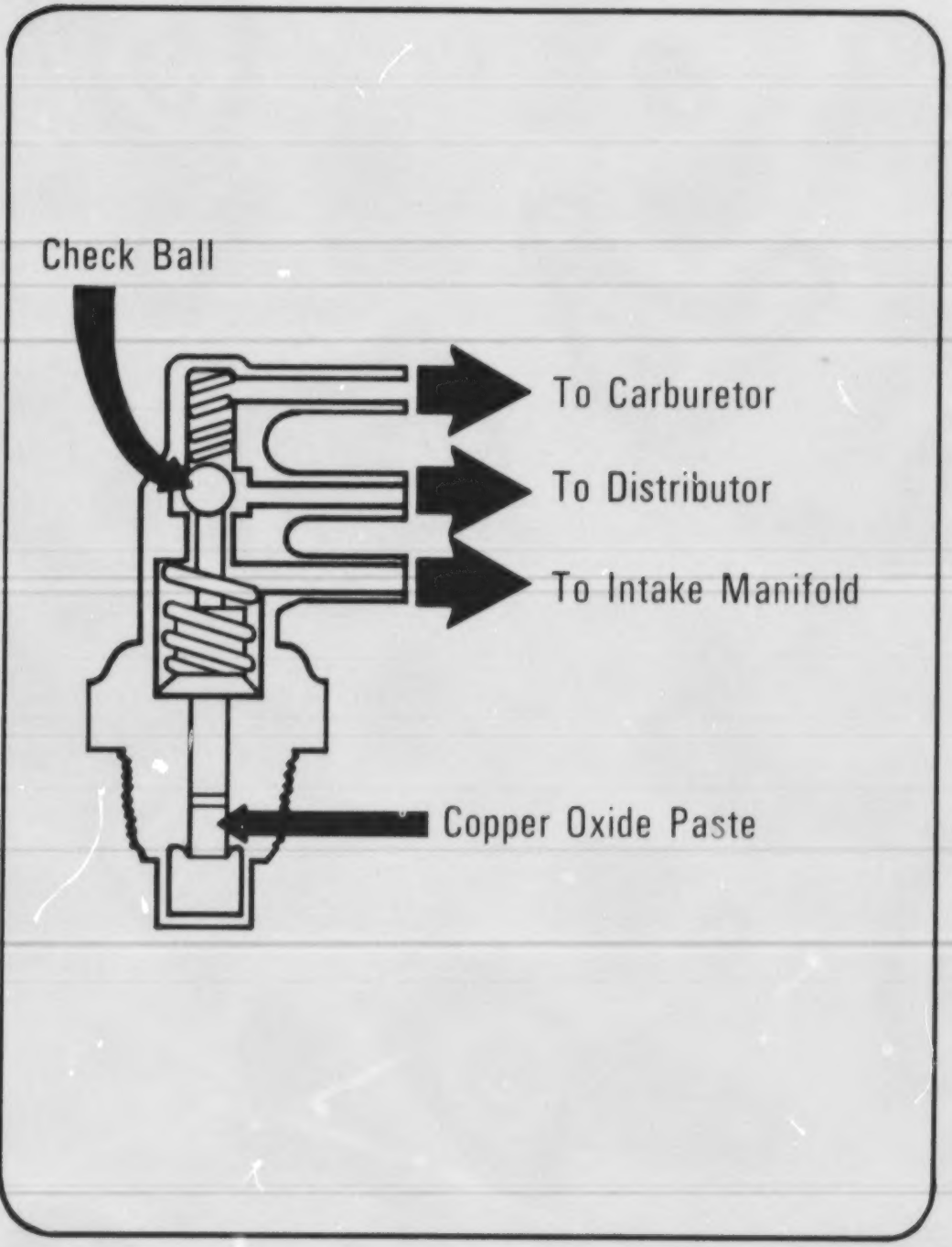
   2. Provides carburetor vacuum through SDV to distributor

E. During overheating conditions the main PVS:

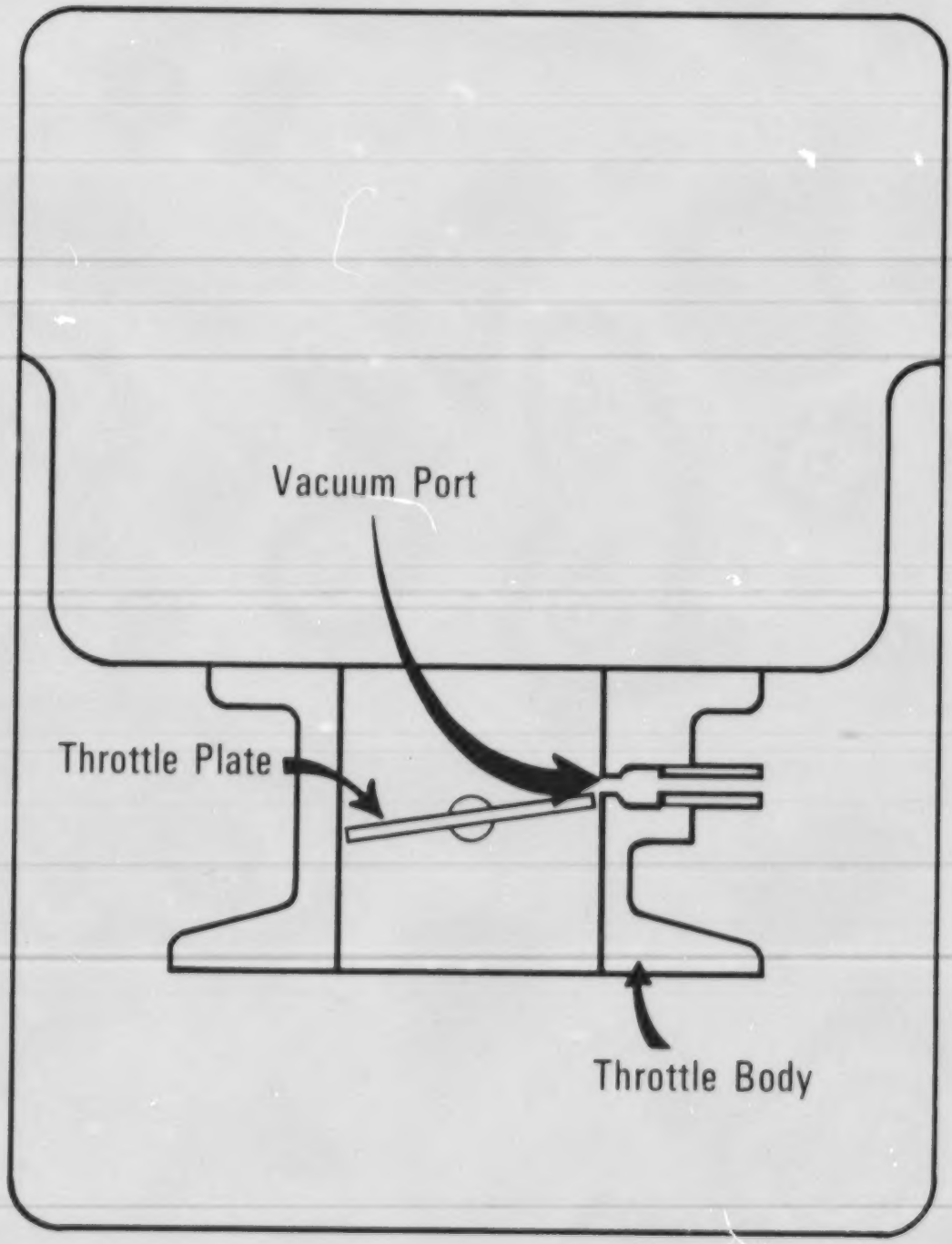
   1. Cuts off carburetor vacuum

   2. Directs manifold vacuum to distributor

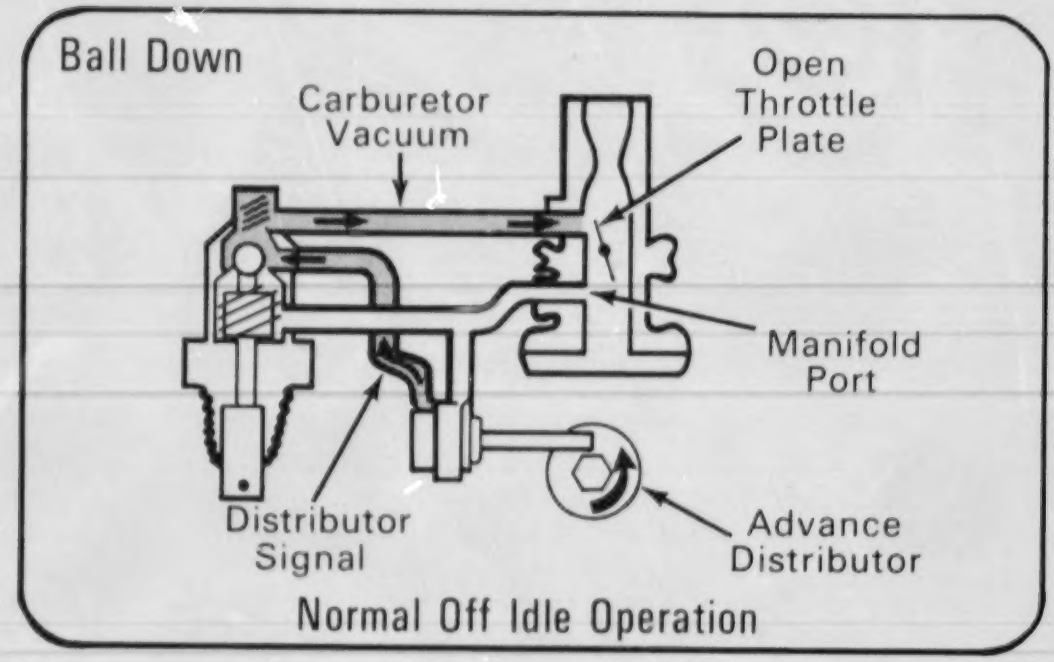
Thermostatic Vacuum Switch
TVS/PVS

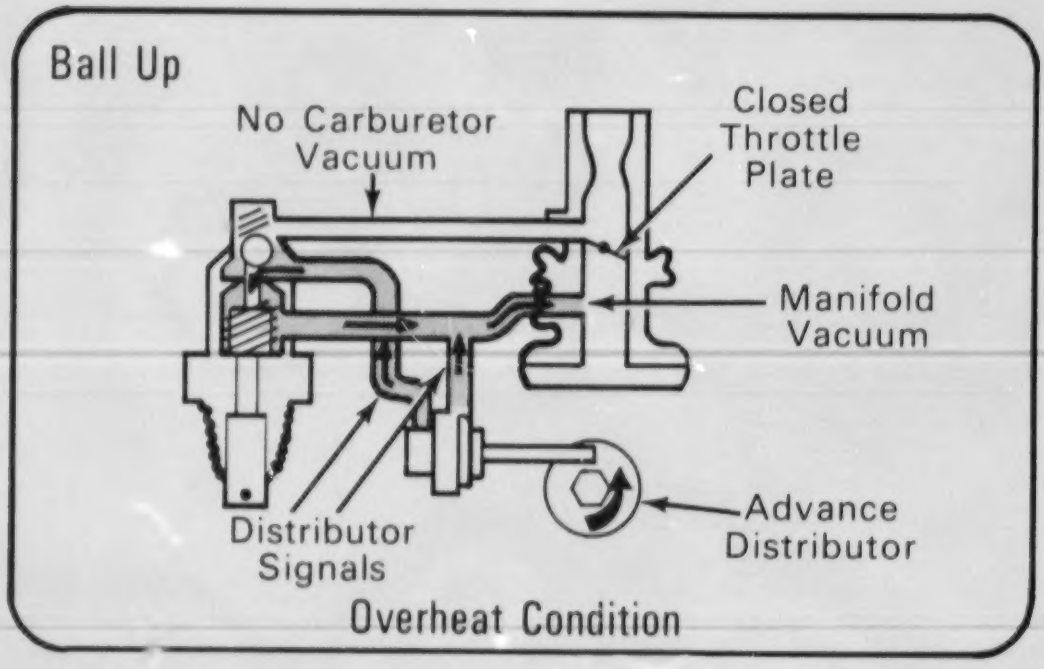


Carburetor Vacuum Advance Port

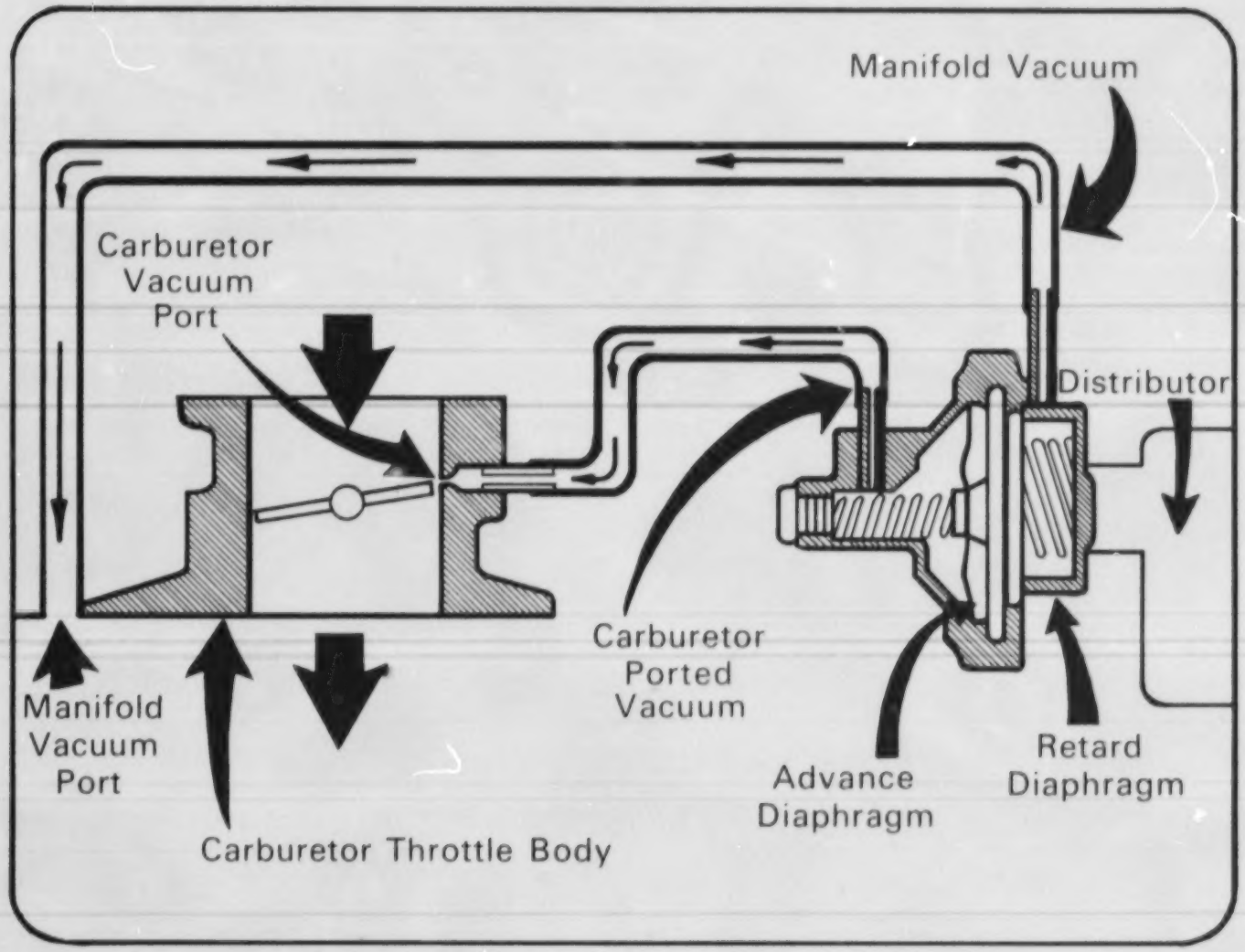


Thermostatic Vacuum Switch Operation





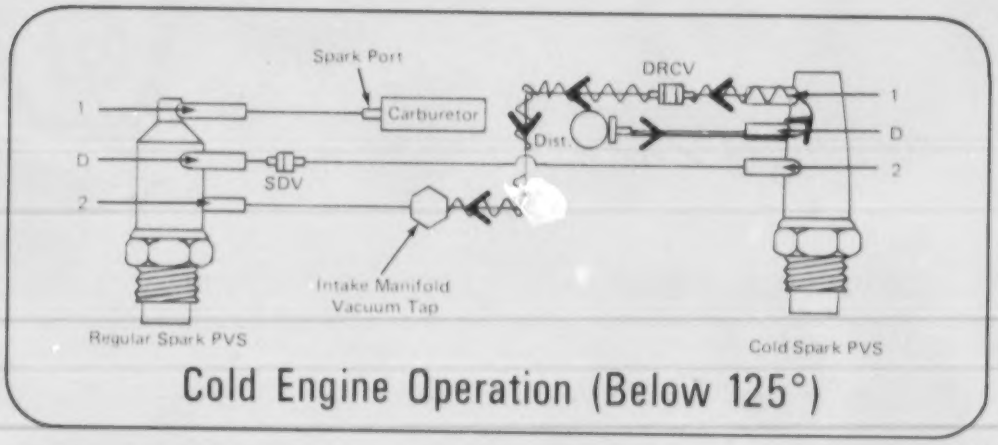
Dual Diaphragm Vacuum Advance Unit & Operation



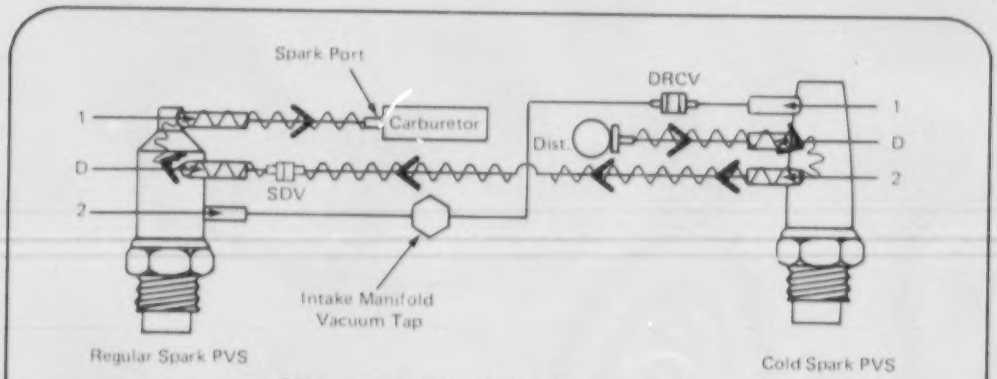
TM 4

AEC 169

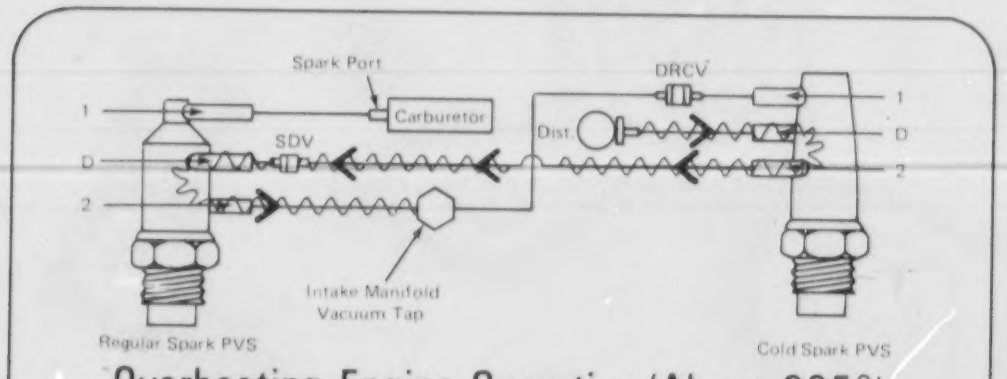
Spark Control Operation Using Multiple TVS/PVS Valves



Cold Engine Operation (Below 125°)



Normal Engine Operation



Overheating Engine Operation (Above 235°)

IGNITION TIMING SYSTEM
UNIT VIII

JOB SHEET #1--TEST FOR PROPER OPERATION OF THE THERMOSTATIC VACUUM SWITCH

I. Tools and equipment

A. Two vacuum gauges

B. Vacuum pump or outside vacuum source

II. Procedures

A. Disconnect vacuum hoses from TVS/PVS unit

(NOTE: This description is for a 3 connector TVS. The basic procedures can be repeated as needed for other applications.)

B. Connect a vacuum pump to the center or distributor port

C. Connect one vacuum gauge to both top (carburetor) and bottom (manifold) port

D. With engine coolant temperature at normal temperature apply vacuum to the TVS

E. The top gauge should have the same reading as the source gauge and no vacuum should be present at the bottom gauge

F. If no vacuum is noticed at top gauge, replace TVS

G. Raise the engine coolant temperature to overheat conditions by covering the radiator

(CAUTION: This condition should be maintained for no longer than 3 minutes.)

(NOTE: The temperature will increase due to lack of airflow through the radiator. The TVS will operate before overheat conditions occur so there is ample prevention time to perform testing activities.)

H. Apply vacuum to the TVS and note readings on the gauges

I. There should be no vacuum on the top gauge and equal readings on the middle and bottom gauges

J. If no vacuum switch exists on bottom gauge, replace TVS

K. Remove radiator covering and reconnect vacuum hoses

JOB SHEET # 1

L. Allow engine to run at fast idle for a few minutes to lower coolant temperature

(NOTE: When performing these tests, be certain radiator cap and all water hoses are in working condition to prevent damage to engine or loss of coolant.)

M. An alternative check on overheating operation can be performed by noting engine R.P.M. increase when vacuum hoses are reconnected

(NOTE: These are general service procedures. For exact procedures and calibrations, check manufacturer's shop manuals.)

IGNITION TIMING SYSTEM
UNIT VIII

JOB SHEET #2 TEST FOR PROPER OPERATION OF THE VACUUM ADVANCE UNIT

I. Tools and equipment

A. Tachometer

B. Vacuum pump or external vacuum source

C. Line plugs

D. Shop hand tools

E. Timing light

II. Procedure

A. Set parking brake and block drive wheels

B. Place transmission in park or neutral

C. Connect a tachometer and timing light to engine

(NOTE: An oscilloscope may be used if available.)

D. Start engine and allow to warm to normal operating temperature

E. Check for loose, cracked, or damaged vacuum hoses

F. Note tachometer reading when warm

G. Disconnect vacuum advance hose and retard hose at distributor and plug both hoses after determining if vacuum is present

H. Set engine idle to manufacturer's specifications and adjust timing to normal retard reading

I. Check for centrifugal advance by accelerating the engine to approximately 1500 R.P.M. and noting timing mark position; repeat acceleration a few times

J. Apply approximately 15 inches Hg of vacuum to distributor advance connections

K. Note R.P.M. increase and determine if vacuum is held by the diaphragm for approximately one minute

L. If no R.P.M. increase is noted or if vacuum is not held, replace the advance assembly

JOB SHEET #2

M. Apply the vacuum source to the distributor retard connection and note R.P.M. decrease

N. If no drop is noted, replace vacuum unit

O. Stop engine, remove equipment and reconnect vacuum hoses

(NOTE: These procedures are general service descriptions. For exact settings and calibrations, check manufacturer's shop manuals.)

IGNITION TIMING SYSTEM
UNIT VIII

NAME _____

TEST

1. Match the components on the right to the correct functions.

_____a. A vacuum regulated device on the distributor that advances engine timing on impulse from the carburetor port or retards timing when a signal is received from the manifold port

_____b. An opening above the carburetor throttle plate which provides carburetor vacuum when the throttle plate is opened

_____c. A dual function valve which delays or restricts vacuum advance during rapid acceleration and cuts off vacuum advance on deceleration

_____d. A temperature sensitive valve which regulates vacuum from carburetor or manifold ports to vacuum advance unit according to engine coolant temperature

_____e. A control valve which restricts spark retardation signals to the distributor during conditions of cold engine temperatures

_____f. A temperature sensitive valve which directs vacuum advance during conditions of engine overheating

_____g. A single function valve which restricts vacuum advance to the distributor during rapid acceleration but does not cut off vacuum on deceleration

1. Orifice spark advance control (OSAC)
2. Coolant temperature override valve (CTO)
3. Dual diaphragm vacuum advance unit
4. Vacuum port
5. Thermostatic vacuum switch (TVS/PVS)
6. Spark delay valve (SDV)
7. Distributor retard control valve (DRCV)

2. State the purpose of the ignition timing system.

3. Describe the operation of the thermostatic vacuum switch.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

4. Describe the operation of the dual diaphragm vacuum advance unit.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

5. Explain the operation of the cold start spark advance system.

   a.

   b.

   c.

   d.

   e.

6. Demonstrate the ability to:

   a. Test for proper operation of the thermostatic vacuum switch.

   b. Test for proper operation of the vacuum advance unit.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

IGNITION TIMING SYSTEM
UNIT VIII

ANSWERS TO TEST

1. a. 3
   b. 4
   c. 6
   d. 5
   e. 7
   f. 2
   g. 1
2. The purpose of the ignition timing system is to regulate the timing of an automobile engine to provide more effective emission control during conditions of engine idle and deceleration
3. Description should include:
   a. Engine temperature is sensed by the TVS probe in the engine coolant
   b. Under normal conditions the check ball is in a down position
   c. Vacuum is directed from carburetor port to distributor vacuum advance unit
   d. When engine temperature rises above 210° the check ball is forced upward
   e. Vacuum from carburetor port is cut off
   f. Vacuum is directed from the manifold port to the distributor
   g. A decrease in engine temperature allows the check ball to return to normal position
4. Description should include:
   a. Vacuum signals are received from the carburetor port or intake manifold port
   b. The outer diaphragm operates on carburetor vacuum to advance timing
   c. The inner (retard) diaphragm operates on manifold vacuum
   d. Calibrated springs center the diaphragm under low vacuum conditions
   e. The advance diaphragm is connected to the breaker plate of the distributor
   f. Movement of the diaphragms increases or decreases spark timing as the breaker plate moves with or against the distributor rotation

g. Under overheat or cold start conditions, manifold vacuum is provided to the advance diaphragm to provide needed timing increases

h. Under deceleration conditions the weak carburetor signal to the advance diaphragm is overcome by retard diaphragm because of a strong manifold vacuum supply and spark timing is retarded

5. Explanation should include:

a. The system consists of two PVS controls with different temperature ranges

b. Under normal conditions, the main PVS directs carburetor vacuum signals to the distributor

c. During cold start conditions the CSSA PVS:

1. Cuts off carburetor vacuum from main PVS

2. Provides manifold vacuum through DRCV to distributor

d. Above 125°F the CSSA PVS:

1. Cuts off manifold vacuum

2. Provides carburetor vacuum through SDV to distributor

e. During overheating conditions, the main PVS:

1. Cuts off carburetor vacuum

2. Directs manifold vacuum to distributor

6. Performance skills evaluated to the satisfaction of the instructor

SPARK ADVANCE CONTROLS
UNIT IX

UNIT OBJECTIVE

After completion of this unit, the student should be able to state the purpose of the transmission controlled spark system and explain the operation of the components of the system. The student should also be able to demonstrate the ability to visually inspect, test, and service the components of the system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. State the purpose of the transmission controlled spark system.
2. Match the components of the transmission controlled spark system to their correct functions.
3. Write abbreviations generally used with common terms and components of transmission controlled spark systems when given the term or component.
4. Distinguish between the components of a speed controlled system and a transmission regulated system.
5. Explain the operation of the transmission regulated spark system.
6. Explain the operation of a speed controlled spark system.
7. Demonstrate the ability to determine the proper operation of a transmission controlled spark system.

SPARK ADVANCE CONTROLS
UNIT IX

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined on the job sheet.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheet.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Speed Controlled System

2. TM 2--Transmission Regulated System

D. Job Sheet #1--Determine the Proper Operation of Transmission Controlled Spark Systems

E. Test

F. Answers to test

II. References:

A. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

B. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1979.

C. Ford Motor Company. *Vehicle Emission Control Systems.* Detroit, Michigan: Service Publications/Helm, Inc., 1978.

D. General Motors Corporation. *Emissions Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

SPARK ADVANCE CONTROLS
UNIT IX

INFORMATION SHEET

I. Purpose of the transmission controlled spark system--The purpose of the TCS system is to reduce emissions during periods of low speed operation by retarding ignition timing

II. Components and functions

A. Thermostatic vacuum switch (TVS/PVS)--A temperature sensitive valve which regulates vacuum from the carburetor or manifold port to the vacuum advance unit according to engine coolant temperature

B. Transmission switch--A mechanically operated switch located in the transmission which opens or closes an electrical circuit to a vacuum control solenoid depending on gear selection

C. Vacuum control solenoid--An electrically controlled valve which regulates vacuum supply to the distributor vacuum advance unit

D. Speed sensor--A speedometer cable driven device that generates an electrical charge at a predetermined speed to actuate a vacuum control solenoid

E. Ambient temperature switch--A bimetal temperature sensing electrical switch that opens or closes an electrical circuit to a vacuum control solenoid

F. Electronic control module (ECM)--A solid state or magnetic chip computer-like device which analyzes electrical impulses from various sensors and sends appropriate signals to engine controls

G. Speed control switch--A transmission switch linked to the speedometer gear which uses a governor-like method to open or close a circuit to the vacuum control solenoid according to vehicle speed

H. Combination emission control valve (CEC)--A triple function electromagnetic control which operates as a transmission controlled spark solenoid, an idle stop solenoid, and a dashpot on some G.M. autos

I. Electronic amplifier--An electrical control which increases the strength of impulses received from engine sensors and sends the stronger signal to electronic engine controls

III. Common abbreviations for components and terms of the TCS system

A. TCS--Transmission Controlled Spark System

B. NO_x--Chrysler name for Transmission Controlled Spark

C. TRS--Transmission Regulated Spark

INFORMATION SHEET

D. CEC--Combination Emissions Control

E. ECM--Electronic Control Module

F. PVS--Ported Vacuum Switch

G. CTO--Coolant Temperature Override Switch

H. TVS--Thermostatic Vacuum Switch

I. TIC--Thermostatic Ignition Control

J. CCS--Controlled Combustion System

K. OSAC--Orifice Spark Advance Control System

L. ESC--Electronic Spark Control

M. EEC--Electronic Engine Control System

N. SDV--Spark Delay Valve

O. CSC--Coolant Spark Control

P. SCS--Speed Control Switch

Q. SAVM--Spark Advance Vacuum Modulator

R. CSSA--Cold Start Spark Advance

IV. Components found in the two types of transmission controlled spark systems

A. Speed controlled (Transparency 1)

1. Vacuum solenoid
2. PVS overheat system
3. Cold start override system
4. Speed sensor
5. Electronic amplifier

B. Transmission regulated (Transparency 2)

1. Vacuum solenoid
2. PVS overheat system
3. Cold start override system
4. Transmission switch

INFORMATION SHEET

V. Operation of the transmission regulated spark system

(NOTE: On manual transmissions the switch is linkage activated. On automatic transmissions it is operated by fluid pressure. Both are inactive under cold condition because of the cold start override systems utilized to improve driveability.)

A. Normal vacuum advance is provided until engine temperature reaches 95°F or ambient air temperature is above 65°F

(NOTE: Temperature ranges are different for each application.)

B. When vehicle is in 1st or 2nd gear the transmission switch energizes the vacuum solenoid

C. Vacuum is cut off from the vacuum advance unit and timing is retarded

D. When the transmission is in high gear the transmission switch deenergizes the vacuum solenoid

E. Vacuum is restored to the vacuum advance unit to provide normal timing

F. Whenever the transmission is shifted to a lower gear the transmission switch energizes the solenoid and timing is retarded

G. Under engine overheat conditions a PVS will direct manifold vacuum to the advance unit regardless of gear selection

(NOTE: The system is protected by automatically providing manifold vacuum to the advance unit when a system component malfunctions.)

VI. Operation of a speed controlled system

A. Normal vacuum is provided until engine temperature reaches 95°F or ambient air temperature is above 65°F

B. When vehicle speed is below a preset limit the solenoid is energized by the electrical circuit

(NOTE: Vehicle speed is generally preset at lower than 30 mph but this varies with engines and manufacturers.)

C. Vacuum is cut off to the advance unit and timing is retarded

D. When vehicle speed increases above the preset limit, the speed sensor sends an electrical charge to the electronic amplifier

(NOTE: Some systems have a speed sensor that opens an electrical circuit to deenergize the solenoid instead of one that produces an electric charge. They do not use an electronic amplifier.)

E. The amplifier deenergizes the vacuum solenoid

INFORMATION SHEET

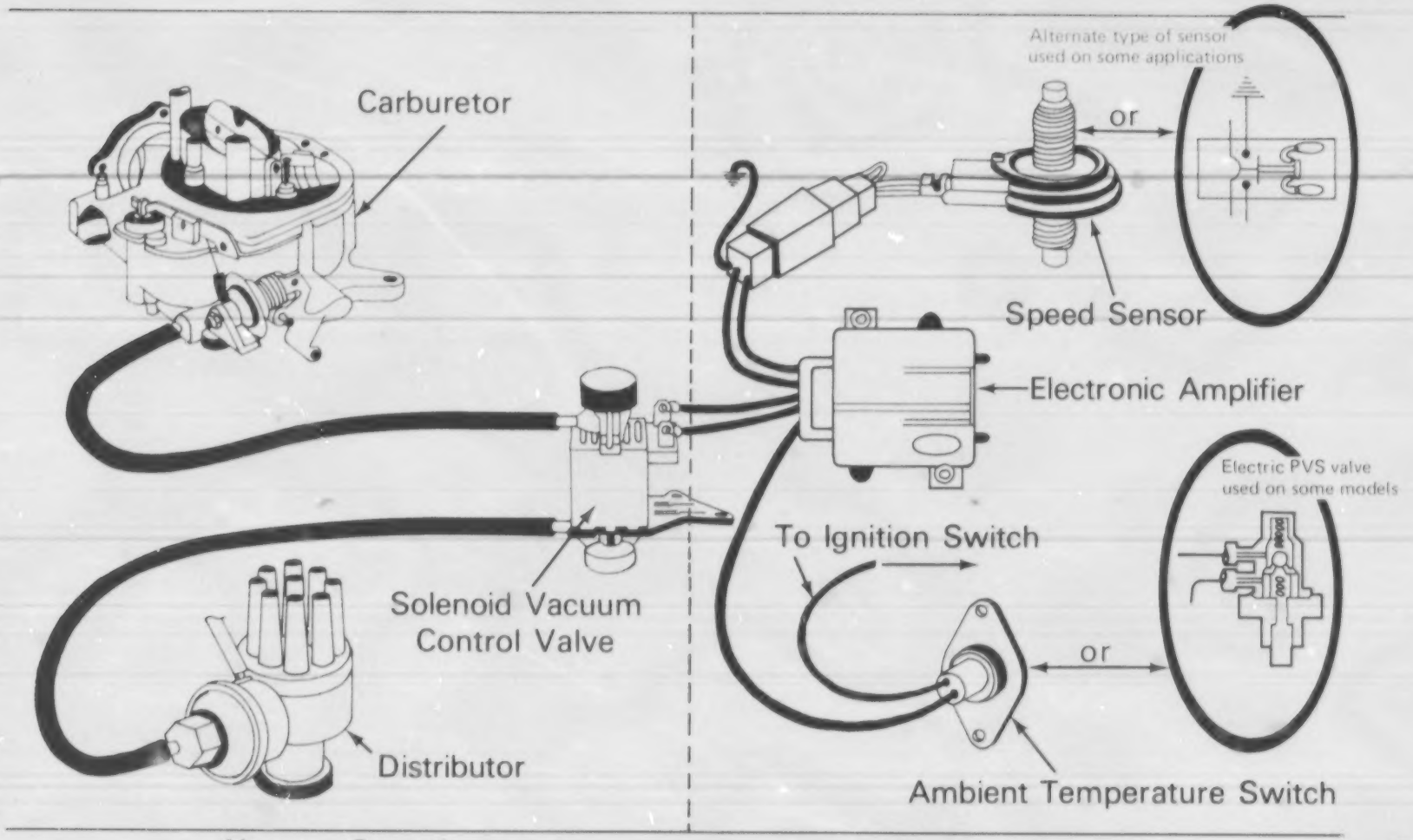
F. Vacuum is restored to the vacuum advance unit to provide normal timing

G. When vehicle speed drops below 20 mph the sensor stops sending signals to the electronic amplifier

H. The vacuum solenoid is energized and timing is retarded

I. Under engine overheat conditions, a PVS will direct manifold vacuum to the advance unit regardless of vehicle speed

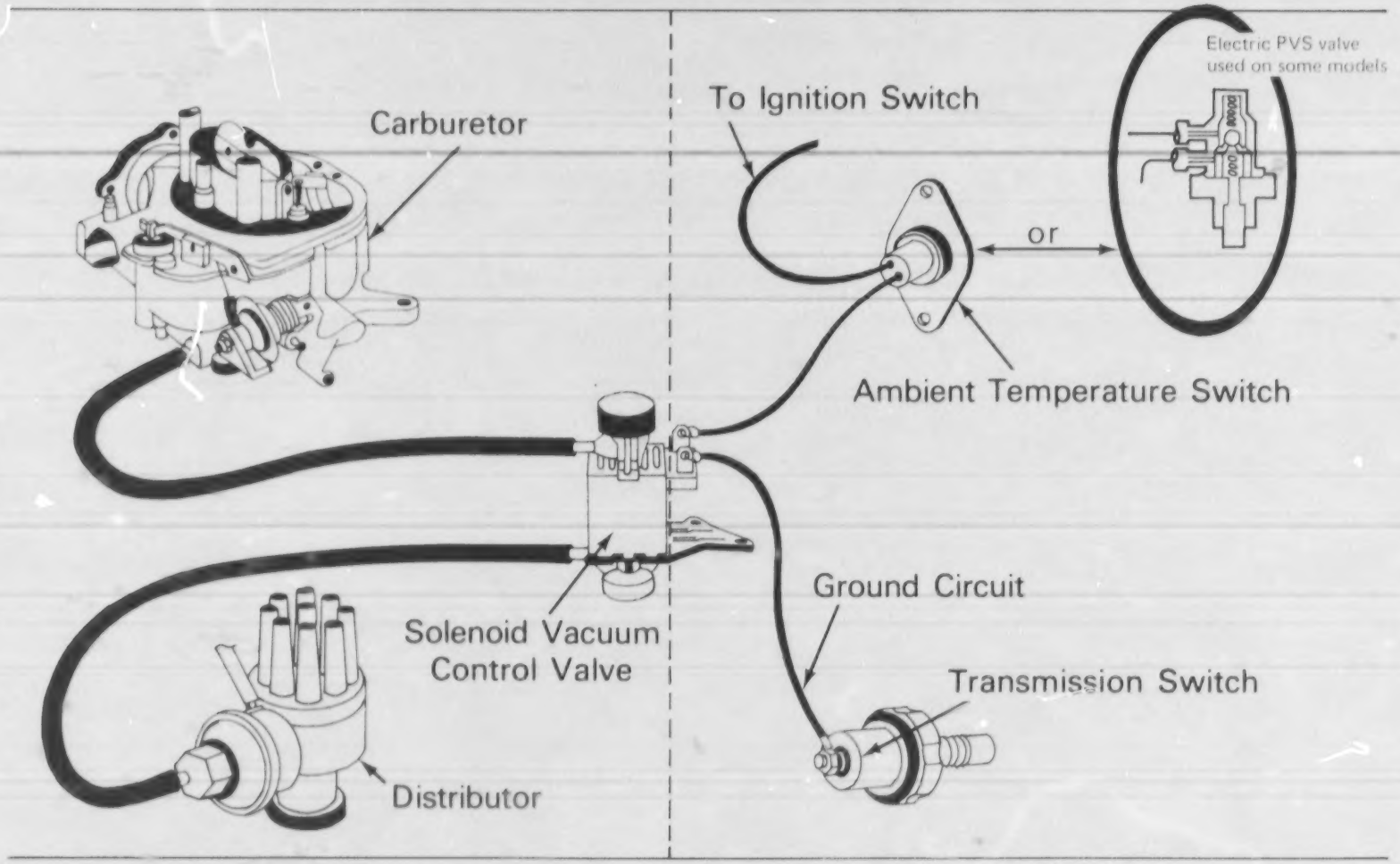
Speed Controlled System



TM 1

AEC 189

Transmission Regulated System



TM 2

AEC 191

SPARK ADVANCE CONTROLS
UNIT IX

JOB SHEET #1–DETERMINE THE PROPER OPERATION OF TRANSMISSION CONTROLLED SPARK SYSTEM

I. Tools and equipment

A. Timing light

B. Tachometer

C. Shop hand tools

D. Freon canister

E. Electric test light

F. Thermometer

II. Procedure:

A. Place vehicle on hoist and elevate so rear wheels are off the ground

B. Connect timing light and tachometer to engine

C. Start engine and note spark advance under cold conditions

D. If equipped with ambient air switch spray with freon to approximate cold conditions and note timing

(NOTE: Steps E through H are for transmission regulated systems. Steps I through Q are for speed controlled systems.)

E. With engine warm, place transmission in low gear and note timing change

F. If timing does not retard in low gear, test electrical circuit to solenoid

G. If current is operational, replace solenoid

H. Place transmission in high gear and note timing advance

(NOTE: If no advance is noted, check for vacuum at distributor. Replace advance unit if no advance is noted when vacuum is present.)

I. With engine warm, place transmission in high gear and adjust engine speed so that vehicle speed is 15 mph and note timing change

JOB SHEET #1

J. If timing does not retard, check electrical current to solenoid

K. If current is operational, replace solenoid

L. Increase engine and vehicle speed to 35 mph and note timing change

M. If no timing advance is noted, check for vacuum at distributor

N. If vacuum is present, replace the advance unit

O. If no vacuum is present, check the electrical circuit from the speed sensor

P. If no charge is being generated, replace the sensor

(NOTE: On some applications a speed switch is used to open a circuit. No current is present in this application at speeds above 35 mph.)

Q. If current is generated by the sensor, check the electronic amplifier or solenoid and adjust or replace as needed

R. Check for engine overheat by placing a piece of cardboard in front of radiator and noting engine timing advance as engine coolant reaches 200°F

(CAUTION: Do not prolong this test for more than 3 minutes. Engine PVS systems operate before overheat conditions so ample time is provided to complete the test. Allow engine to idle before stopping.)

S. Remove all equipment and test apparatus from engine

T. Remove vehicle from the hoist

(NOTE: These procedures are basic. Specific repair procedures are provided in manufacturer's shop manuals. Most components are not serviceable and must be replaced.)

SPARK ADVANCE CONTROLS
UNIT IX

NAME _____

TEST

1. State the purpose of the transmission controlled spark system.

2. Match the components on the right to their correct functions.

_____a. A bimetal temperature sensing electrical switch that opens or closes an electrical circuit to a vacuum control solenoid

_____b. An electrically controlled valve which regulates vacuum supply to the distributor vacuum advance unit

_____c. An electrical control which increases the strength of impulses received from engine sensors and sends the stronger signal to electronic engine controls

_____d. A temperature sensitive valve which regulates vacuum from the carburetor or manifold port to the vacuum advance unit according to engine coolant temperature

_____e. A transmission switch linked to the speedometer gear which uses a governor-like method to open or close a circuit to the vacuum control solenoid according to vehicle speed

_____f. A mechanically operated switch located in the transmission which opens or closes an electrical circuit to a vacuum control solenoid depending on gear selection

_____g. A solid state or magnetic chip computer-like device which analyzes electrical impulses from various sensors and sends appropriate signals to engine controls

1. Thermostatic vacuum switch (PVS/TVS)
2. Transmission switch
3. Vacuum control solenoid
4. Speed sensor
5. Ambient temperature switch
6. Electronic control module (ECM)
7. Speed control switch
8. Combination emission control valve (CEC)
9. Electronic amplifier

_____h. A speedometer cable driven device that generates an electrical charge at a predetermined speed to actuate a vacuum control solenoid

_____i. A triple function electromagnetic control which operates as a transmission controlled spark solenoid, an idle stop solenoid, and a dashpot on some G.M. autos

3. Write the correct abbreviations in the blanks in front of the common terms and components used in the transmission controlled spark system.

_____a. Ported Vacuum Switch

_____b. Coolant Temperature Override Switch

_____c. Electronic Control Module

_____d. Thermostatic Vacuum Switch

_____e. Combination Emissions Control

_____f. Thermostatic Ignition Control

_____g. Transmission Regulated Spark

_____h. Controlled Combustion System

_____i. Chrysler name for Transmission Controlled Spark

_____j. Orifice Spark Advance Control System

_____k. Transmission Controlled Spark System

_____l. Electronic Spark Control

_____m. Cold Start Spark Advance

_____n. Electronic Engine Control System

_____o. Spark Advance Vacuum Modulator

_____p. Spark Delay Valve

_____q. Speed Control Switch

_____r. Coolant Spark Control

4. Distinguish between the components of a speed controlled system and a transmission regulated system by placing an "X" beside the components found in a speed controlled system.

_____a. Cold start override system

_____b. PVS overheat system

_____c. Transmission switch

_____d. Electronic amplifier

_____e. Vacuum solenoid

_____f. Speed sensor

5. Explain the operation of the transmission regulated spark system.

a.

b.

c.

d.

e.

f.

g.

6. Explain the operation of the speed controlled spark system.

a.

b.

c.

d.

e.

f.

g.

h.

i.

7. Demonstrate the ability to determine the proper operation of a transmission controlled spark system.

   (NOTE: If this activity has not been completed prior to the test, ask your instructor when it should be accomplished.)

SPARK ADVANCE CONTROLS
UNIT IX

ANSWERS TO TEST

1. The purpose of the TCS system is to reduce emissions during periods of low speed operation by retarding ignition timing

2. a. 5
   b. 3
   c. 9
   d. 1
   e. 7
   f. 2
   g. 6
   h. 4
   i. 8

3. a. PVS
   b. CTO
   c. ECM
   d. TVS
   e. CEC
   f. TIC
   g. TRS
   h. CCS
   i. NO_x
   j. OSAC
   k. TCS
   l. ESC
   m. CSSA
   n. EEC
   o. SAVM
   p. SDV
   q. SCS
   r. CSC

4. a, b, d, e, f

5. Explanation should include:

   a. Normal vacuum advance is provided until engine temperature reaches 95°F or ambient air temperature is above 65°F

   b. When vehicle is in 1st or 2nd gear the transmission switch energizes the vacuum solenoid

   c. Vacuum is cut off from the vacuum advance unit and timing is retarded

   d. When the transmission is in high gear the transmission switch deenergizes the vacuum solenoid

   e. Vacuum is restored to the vacuum advance unit to provide normal timing

   f. Whenever the transmission is shifted to a lower gear the transmission switch energizes the solenoid and timing is retarded

   g. Under engine overheat conditions a PVS will direct manifold vacuum to the advance unit regardless of gear selection

6. Explanation should include:

   a. Normal vacuum is provided until engine temperature reaches 95°F or ambient air temperature is above 65°F

   b. When vehicle speed is below a preset limit the solenoid is energized by the electrical circuit

   c. Vacuum is cut off to the advance unit and timing is retarded

   d. When vehicle speed increases above the preset limit, the speed sensor sends an electrical charge to the electronic amplifier

   e. The amplifier deenergizes the vacuum solenoid

   f. Vacuum is restored to the vacuum advance unit to provide normal timing

   g. When vehicle speed drops below 20 mph the sensor stops sending signals to the electronic amplifier

   h. The vacuum solenoid is energized and timing is retarded

   i. Under engine overheat conditions a PVS will direct manifold vacuum to the advance unit regardless of vehicle speed

7. Performance skills evaluated to the satisfaction of the instructor

EXHAUST CROSSOVER SYSTEM
UNIT X

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the purpose of the exhaust crossover system and demonstrate the ability to check for proper operation of the system and make needed adjustments. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match the components of the exhaust crossover system to the correct functions.
2. State the purpose of the exhaust crossover system.
3. List effects of the exhaust crossover system on an automobile engine.
4. Explain the operation of the exhaust crossover system.
5. Demonstrate the ability to check for proper operation of the exhaust crossover system and make needed adjustments.

EXHAUST CROSSOVER SYSTEM
UNIT X

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Demonstrate and discuss the procedures outlined in the job sheet.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheet.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1-Types of Exhaust Valves

2. TM 2-Exhaust Valve Operation

D. Job Sheet #1-Check for Proper Operation of the Exhaust Crossover System and Make Needed Adjustments

E. Test

F. Answers to test

II. References:

A. Chrysler Corporation, *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Service Department, 1978.

B. Ford Motor Company. *Vehicle Emission Control Systems.* Detroit, Michigan: Service Publications/Helm, Inc., 1978.

C. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

D. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1979.

E. General Motors Corporation. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

EXHAUST CROSSOVER SYSTEM
UNIT X

INFORMATION SHEET

I. Components and functions

A. Exhaust valve--Restricts the flow of exhaust gas from the exhaust manifold (Transparency 1)

B. Vacuum actuator (motor)--Opens or closes the exhaust valve according to vacuum signals from engine (Transparency 1)

C. Thermal vacuum switch (TVS/PVS)--Controls vacuum signal to vacuum motor by closing off vacuum when engine temperatures increase (Transparency 2)

D. Thermostatic coil--Opens or closes the exhaust valve according to the surface temperatures of the exhaust manifold (Transparency 1)

(NOTE: A thermostatically controlled system is used on some applications. This system is the same as that used in older model applications prior to emissions requirements.)

II. Purpose of the exhaust crossover system--The purpose of the exhaust crossover system is to preheat intake gases to improve evaporation and distribution of the air/fuel mixture

III. Effects of the exhaust crossover system on an automobile engine

A. Shorter choke periods

B. Better driveability

C. Helps eliminate condensation of fuel

D. Provides improved evaporation of fuel mixture

E. Reduces hydrocarbon emissions

IV. Operation of exhaust crossover system (Transparency 2)

A. Under cold engine conditions the thermal vacuum valve (TVS/PVS) is open

B. Vacuum is provided to the vacuum actuator (motor) which closes the exhaust valve

(NOTE: The exhaust valve is spring loaded to remain open unless vacuum is delivered to the vacuum motor which overcomes spring tension and holds the valve in a closed position. The valve is made of stainless steel to prevent corrosion.)

INFORMATION SHEET

C. Exhaust gases are restricted from passing through the exhaust pipe

(NOTE: Normally the exhaust valve is located on one of the exhaust manifolds (V-8) and gases are routed through the intake manifold riser before entering the exhaust system on the opposite side.)

D. Gases are forced to flow through a passage in the intake manifold

E. Intake mixtures are heated by exhaust gases

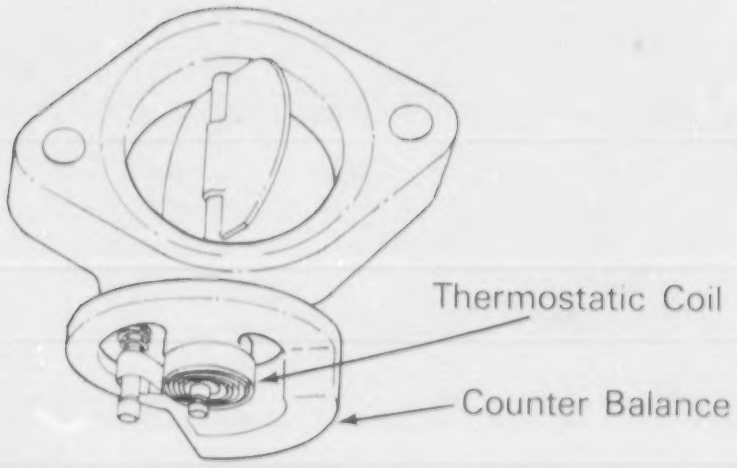
F. When the engine warms up to predetermined temperature, the TVS/PVS cuts off vacuum to valve motor

(NOTE: The thermostatic coil system provides the same function of routing exhaust gases to intake manifold but it operates by sensing the surface temperature of the exhaust manifold to open the valve.)

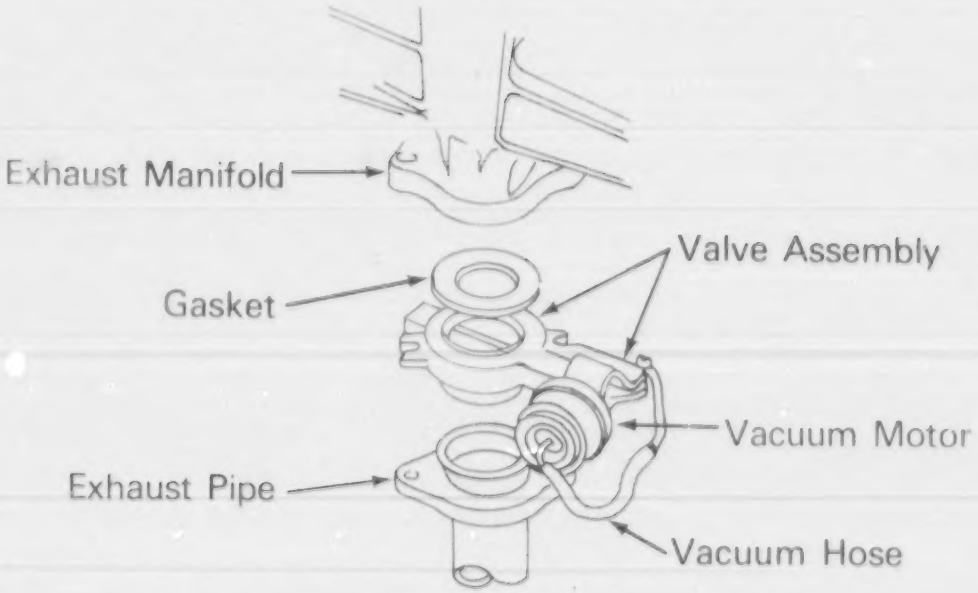
G. The spring in the valve opens the valve and restores normal exhaust flow

(NOTE: There are many modifications of the system in use. GM uses either a coolant TVS or an oil TVS. Ford uses a thermostatically controlled valve or a vacuum operated valve with a coolant PVS as does Chrysler. Most smaller engine [4 and 6 cylinder] applications use a thermostatic valve.)

Types of Exhaust Valves

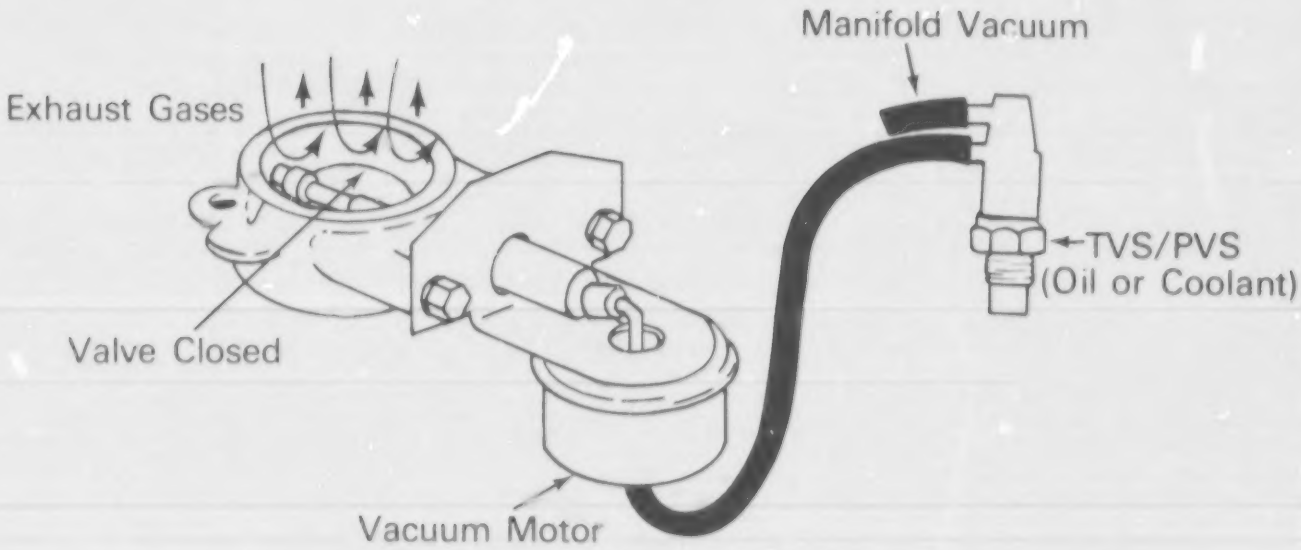


Thermostatically-Operated Exhaust Valve

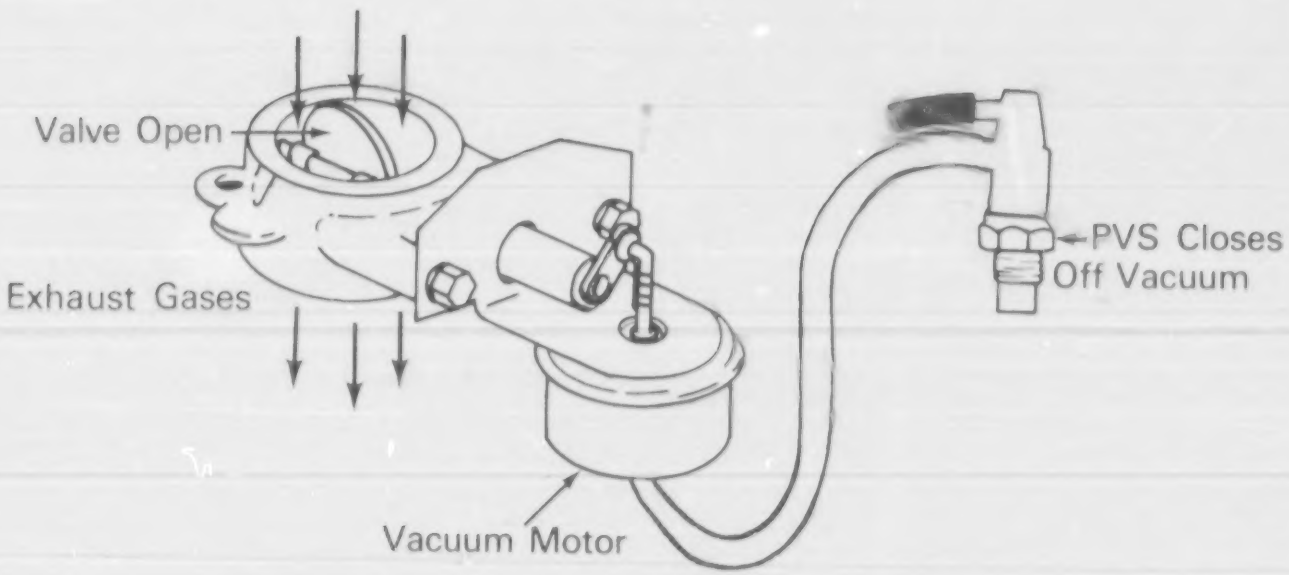


Vacuum Operated Valve

Exhaust Valve Operation



Cold Engine Operation



Warm Engine Operation

EXHAUST CROSSOVER SYSTEM
UNIT X

JOB SHEET #1 CHECK FOR PROPER OPERATION OF EXHAUST CROSSOVER SYSTEM AND MAKE NEEDED ADJUSTMENTS

I. Tools and equipment

A. Shop hand tools

B. Heat valve lubricant

C. Tachometer

II. Procedure

A. Visually inspect system for damage

B. Move exhaust valve by hand to determine freedom of movement

C. If movement is restricted, spray valve assembly with lubricant

(NOTE: Normal servicing of the system calls for lubrication of the valve so it should be sprayed whenever it is checked. A damaged valve should be replaced.)

D. With cold engine, place transmission in park (automatic) or in neutral (standard) and block wheels

E. Attach a tachometer to the engine

F. Start engine and adjust idle to approximately 1,500 rpm

G. Remove vacuum hose from vacuum motor

H. Check for vacuum by placing finger over the end of the hose

(NOTE: Under cold engine conditions there should be vacuum to the vacuum motor from the TVS/PVS to close the valve assembly.)

I. If vacuum is present, replace the hose

(NOTE: If no vacuum is found replace the PVS or determine if hoses are connected properly or cracked.)

J. Allow the engine to warm to normal operating temperature

K. Remove the vacuum hose from the motor assembly and check for vacuum

JOB SHEET #1

L. If no vacuum is present, replace the hose

(NOTE: Under normal operating conditions, the vacuum is cut off by the PVS to allow the valve to open. If vacuum is present, the PVS is faulty and must be replaced.)

M. Stop the engine, disconnect tachometer, and remove all shop equipment from the engine

(NOTE: These are basic procedures. Some manufacturer's manuals suggest using a vacuum pump and other tools. Check the manufacturer's manual for exact procedures and settings.)

EXHAUST CROSSOVER SYSTEM
UNIT X

NAME _____

TEST

1. Match the components of the exhaust crossover sytem on the right to their correct functions.

_____a. Restricts the flow of exhaust gas from the exhaust manifold	1. Thermostatic coil
_____b. Opens or closes the exhaust valve according to vacuum signals from engine	2. Vacuum actuator (motor)
_____c. Controls vacuum signal to vacuum motor by closing off vacuum when engine temperatures increase	3. Exhaust valve
_____d. Opens or closes the exhaust valve according to the surface temperatures of the exhaust manifold	4. Thermal vacuum switch (TVS/PVS)

2. State the purpose of the exhaust crossover system.

3. List four effects of the exhaust crossover system on an automobile engine.

   a.

   b.

   c.

   d.

4. Explain the operation of the exhaust crossover system.

   a.

   b.

   c.

d.

e.

f.

g.

5. Demonstrate the ability to check for proper operation of the exhaust crossover system and make needed adjustments.

(NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

EXHAUST CROSSOVER SYSTEM
UNIT X

ANSWERS TO TEST

1. a. 3

   b. 2

   c. 4

   d. 1

2. The purpose of the exhaust crossover system is to preheat intake gases to improve evaporation and distribution of the air/fuel system.

3. Any four of the following:

   a. Shorter choke periods

   b. Better driveability

   c. Helps eliminate condensation of fuel

   d. Provides improved evaporation of fuel mixture

   e. Reduces hydrocarbon emissions

4. Explanation should include:

   a. Under cold engine conditions the thermal vacuum valve (TVS/PVS) is open

   b. Vacuum is provided to the vacuum actuator (motor) which closes the exhaust valve

   c. Exhaust gases are restricted from passing through the exhaust pipe

   d. Gases are forced to flow through a passage in the intake manifold

   e. Intake mixtures are heated by exhaust gases

   f. When the engine warms up to a predetermined temperature, the TVS/PVS cuts off vacuum to valve motor

   g. The spring in the valve opens the valve and restores normal exhaust flow

5. Performance skills evaluated to the satisfaction of the instructor.

EXHAUST GAS RECIRCULATION SYSTEM
UNIT XI

UNIT OBJECTIVE

After completion of this unit, the student should be able to state the purpose of the exhaust gas recirculation (EGR) system. The student should also be able to explain the operation of the EGR system and check for proper operation of the system. This knowledge will be evidenced through demonstraton and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match components associated with the exhaust gas recirculation system to the correct functions.
2. State the purpose of the exhaust gas recirculation system.
3. Explain the operation of the exhaust gas recirculation system.
4. Demonstrate the ability to check the proper operation of and make necessary repairs to the EGR system.

EXHAUST GAS RECIRCULATION SYSTEM
UNIT XI

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined on the job sheet.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheet.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1-Ported Vacuum Control EGR System
2. TM 2-Ported Vacuum Switch PVS (Temperature Controlled Vacuum Valve)
3. TM 3-Amplified Vacuum Controlled EGR System
4. TM 4-Single Diaphragm EGR Valve
5. TM 5-Dual Diaphragm EGR Valve
6. TM 6-EGR Cooler System

D. Job Sheet #1- Check the Proper Operation of and Make Necessary Repairs to the EGR System

E. Test

F. Answers to test

II. References

A. Chrysler Corporation. *1973 Emission Controls*. Detroit, Michigan: Chrysler Corp.

B. Gargano Promotions. *Vehicle Emission Control*, Detroit, Mich.: Gargano Promotions, 1973.

C. Ford Motor Company. *1978 Full Size Car Shop Manual*. Detroit, Mich.: Helm, Inc., 1978.

D. General Motors Corporation. *1979 Passenger Car Service Manual*. Detroit, Michigan: Service Section/General Motors Corporation, 1979.

E. Ford Motor Company. *Vehicle Emission Control Systems Volume II*. Detroit Michigan: Service Publications/Helm, Inc., 1978.

F. General Motors Corporation. *Emission Control Systems Maintenance Manual*. Detroit, Michigan: Service Section/General Motors Corporation, 1978.

EXHAUST GAS RECIRCULATION SYSTEM
UNIT XI

INFORMATION SHEET

I. Components and functions

A. EGR valve--Meters or regulates the amount of exhaust gas flow to the intake manifold (Transparency 1)

B. Ported vacuum switch (PVS)--A temperature actuated valve which controls vacuum flow from carburetor port to EGR valve according to engine sensor signals (Transparency 2)

C. Timed vacuum port--Slot like opening in the carburetor throttle body above the throttle plate in idle position which provides vacuum signal to system

D. Vacuum amplifier--Increases vacuum signal strength from carburetor timed vacuum port (Transparency 3)

E. Single diaphragm EGR valve--Controlled only by signals from vacuum source (Transparency 4)

F. Dual diaphragm EGR valve--Controlled by both vacuum signals and back pressure from exhaust system (Transparency 5)

G. Back pressure transducer valve--Regulates vacuum signal to EGR valve according to back pressure probe sensors in exhaust system

H. EGR cooler--Uses engine coolant to reduce and regulate recirculating exhaust gas temperature (Transparency 6)

II. Purpose of the exhaust gas recirculation system--The purpose of the exhaust gas recirculation system is to meter exhaust gases to the air/fuel mixture

(NOTE: Exhaust gases contain little oxygen and will not support combustion. They absorb some of the heat of combustion and, therefore, reduce combustion temperatures to control NO_x emissions.)

III. Operation of the exhaust gas recirculation system

A. When the engine is first started and no vacuum is available, the EGR valve is held closed by the spring in the unit

B. When engine speed is increased and engine temperature increases to warm up the temperature controlled valve (PVS), vacuum is directed to the EGR valve

(NOTE: To improve driveability, the PVS closes off vacuum to the EGR valve until engine temperature reaches a predetermined level at which time the PVS opens to provide vacuum to the EGR valve.)

INFORMATION SHEET

C. The vacuum supply causes the diaphragm to lift the valve up to the open position

D. Exhaust gases are metered through the EGR adapter plate and mixed with the air/fuel mixture

E. As engine speed increases, under warm conditions, the manifold vacuum increases which causes the EGR valve to open more fully

(NOTE: Systems using the amplified signal method have the vacuum signal from the carburetor directed to the amplifier unit rather than directly to the EGR valve. The result is the same for both methods; increased vacuum causes greater opening of EGR valve.)

F. Under higher speed conditions a cut off valve reduces manifold vacuum to the EGR valve which causes it to close.

(NOTE: To improve driveability in some engines, a high speed modulator is used to cut off vacuum supply. One system uses an electrical solenoid which overrides the PVS or vacuum amplifier when a signal is received from a speed sensor located on the speedometer cable. When speeds are below the pre-set limit, the system functions normally. Other systems use a modulator valve in the EGR valve which closes the EGR valve when high vacuum conditions exist.)

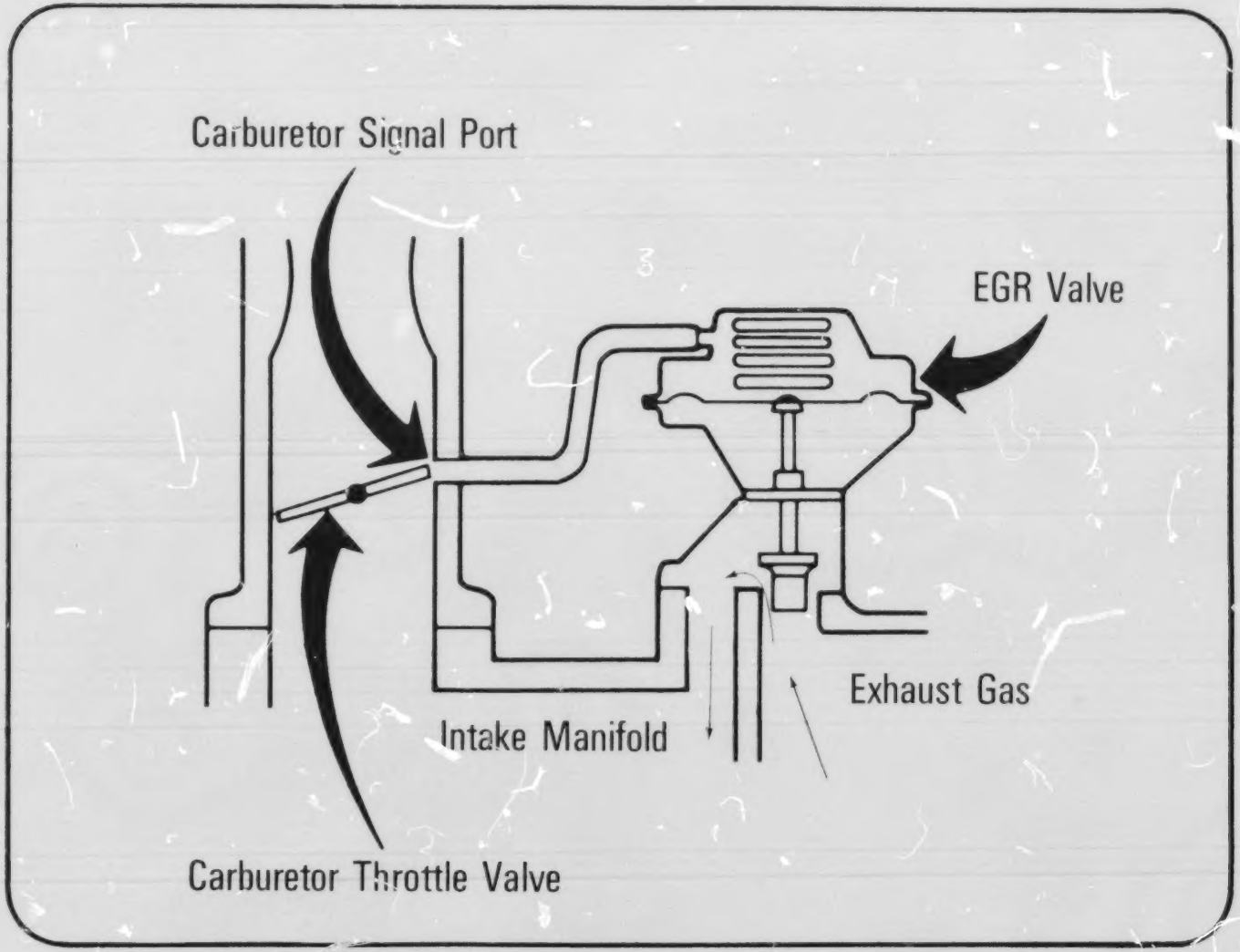
G. Back pressure from the exhaust system is monitored to regulate the EGR valve

(NOTE: As back pressure builds up during acceleration a monitoring system in the EGR valve or in the exhaust system cuts off vacuum to the EGR valve and causes it to close. A dual diaphragm EGR valve is used in some applications and an electronic sensor is used in others.)

H. As the engine shuts down, all components return to closed or "off" position

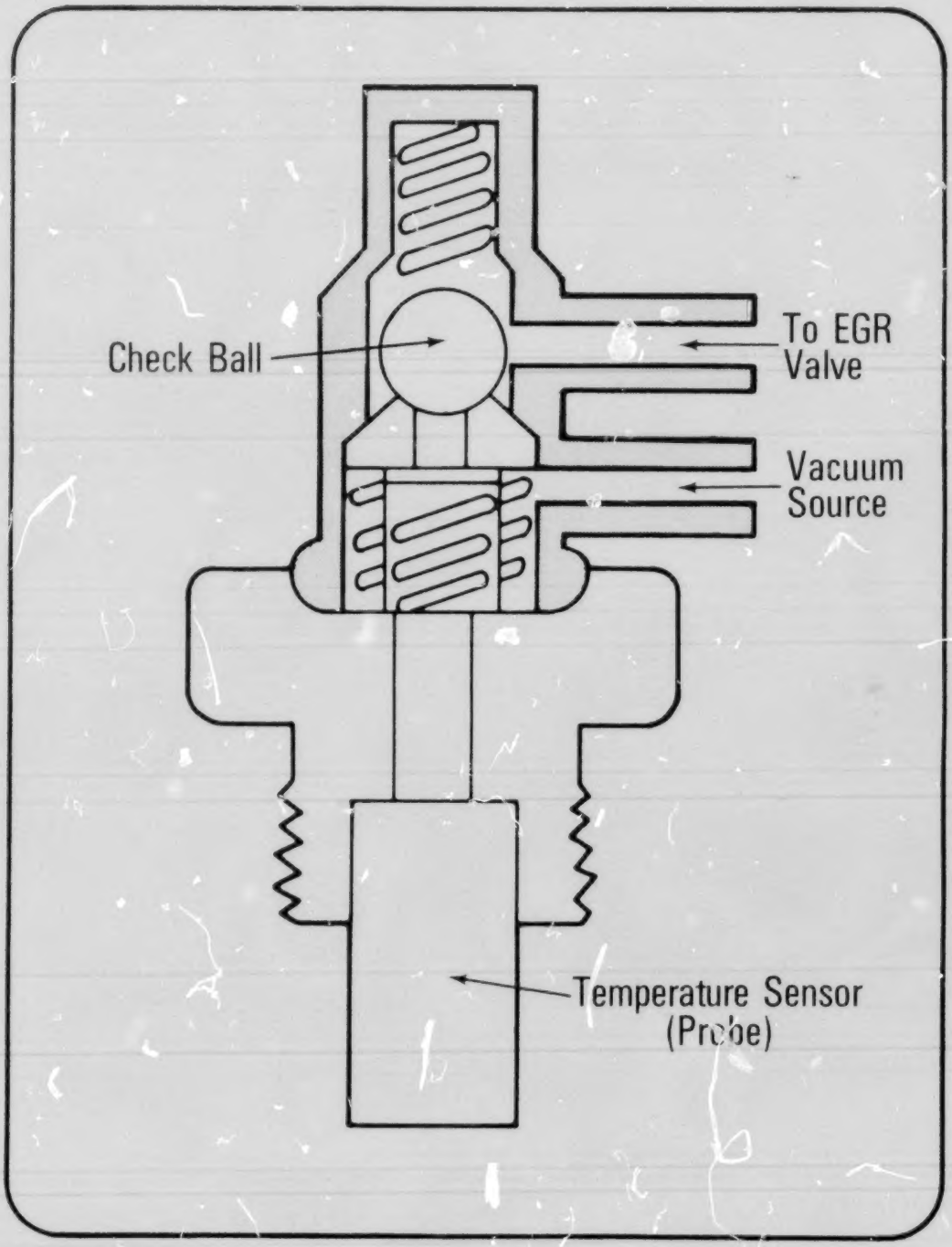
(NOTE: Some newer model applications have an EGR cooling system which uses engine coolant to reduce exhaust gas temperatures. This system provides a uniform gas temperature entering the combustion chambers to assist the combustion process and improve driveability.)

Ported Vacuum Control EGR System

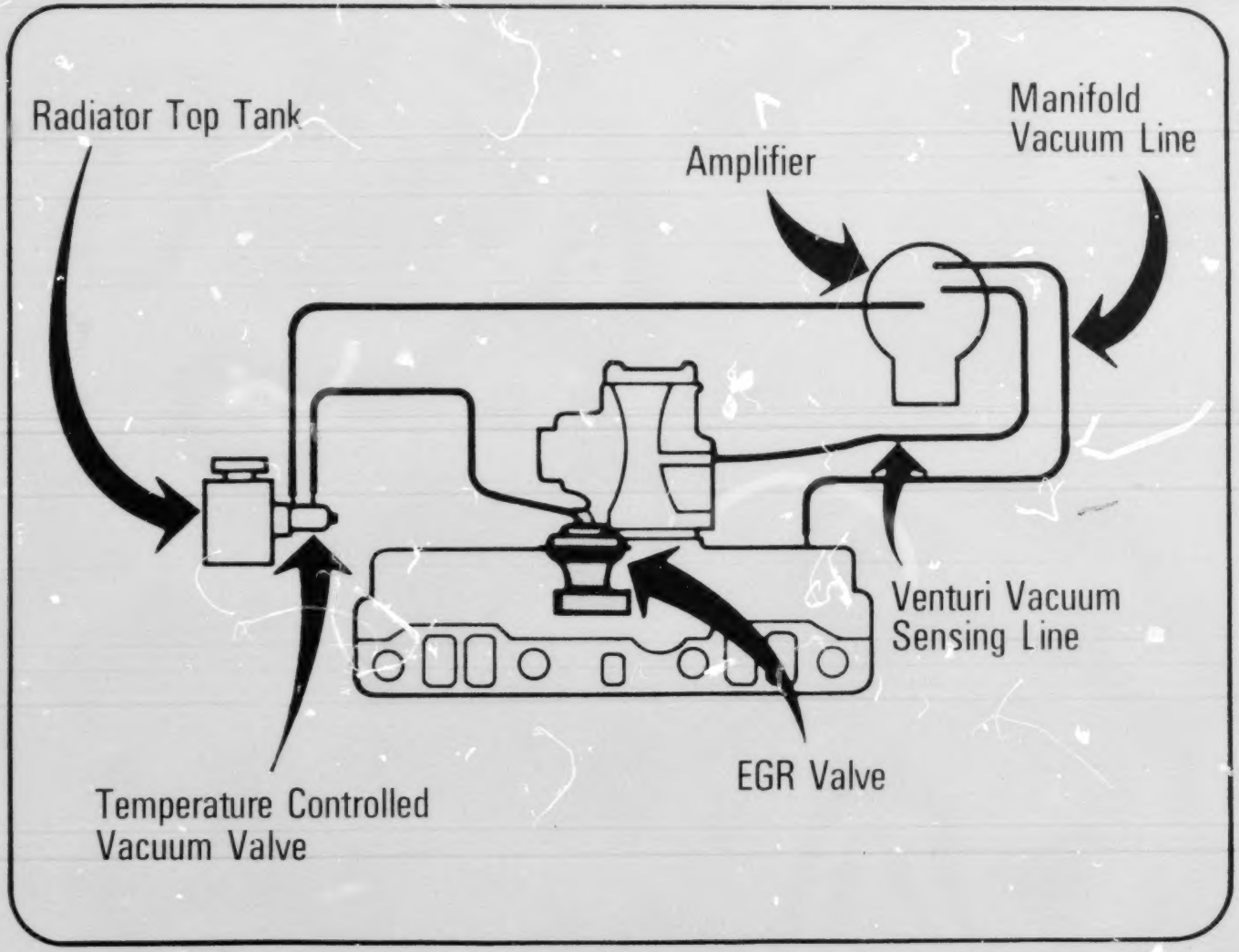


Ported Vacuum Switch-PVS

(Temperature Controlled Vacuum Valve)



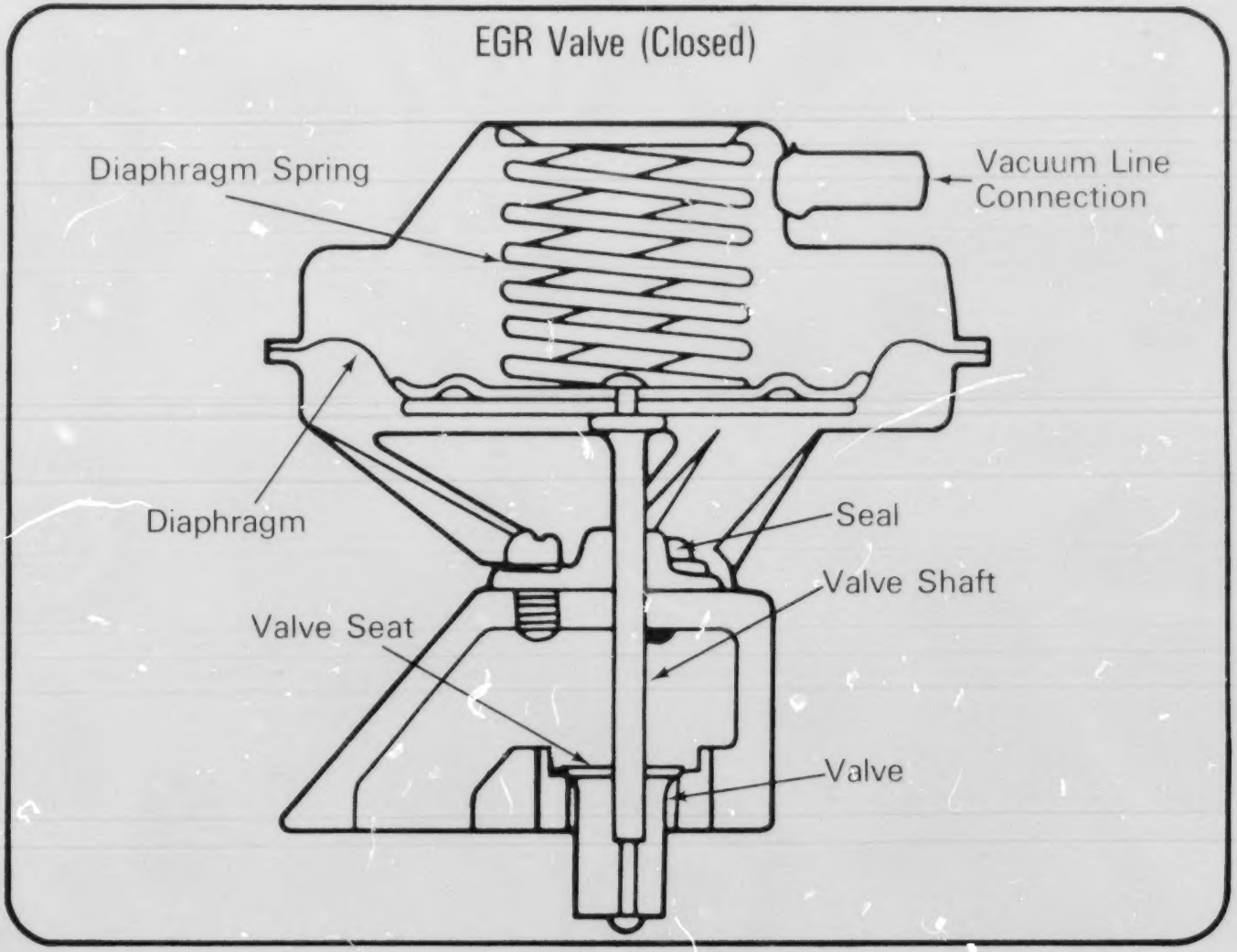
Amplified Vacuum Controlled EGR System



TM 3

AEC 227

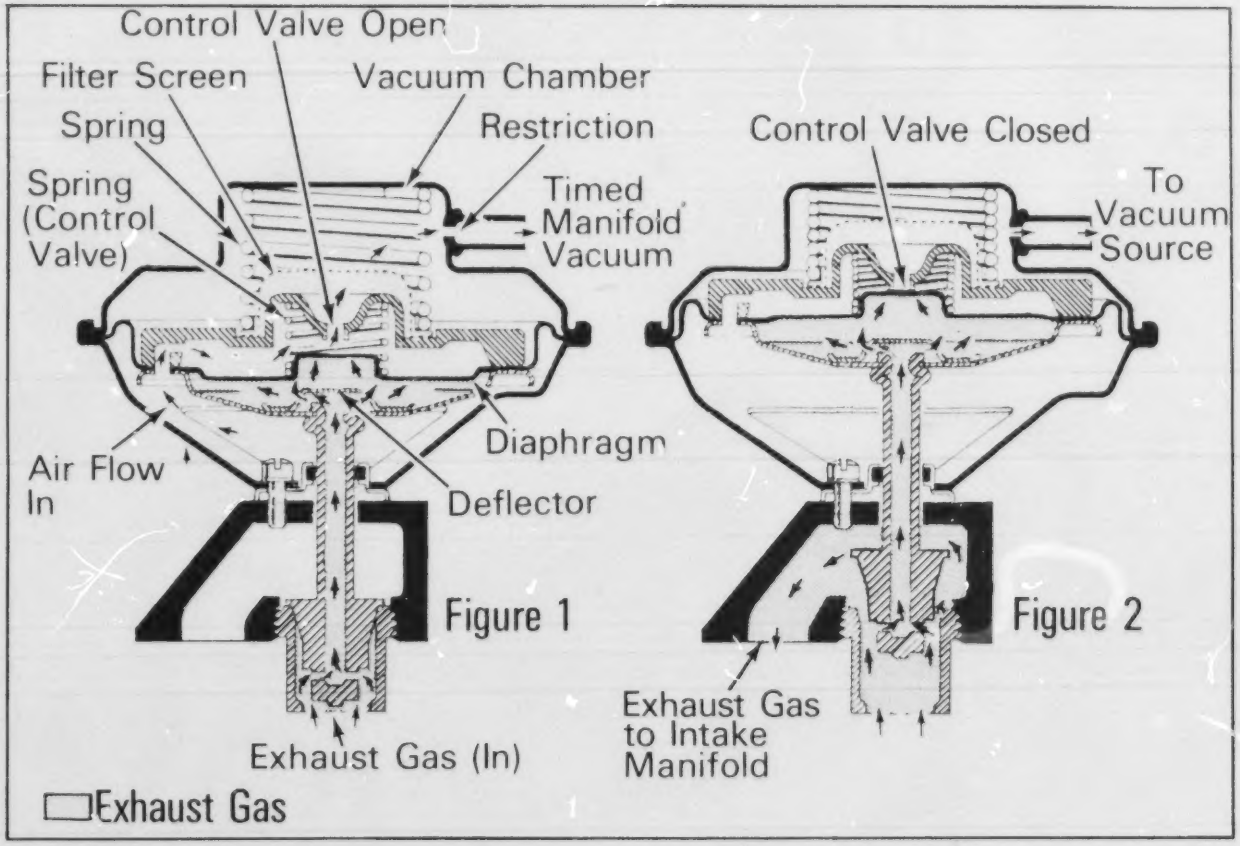
Single Diaphragm EGR Valve



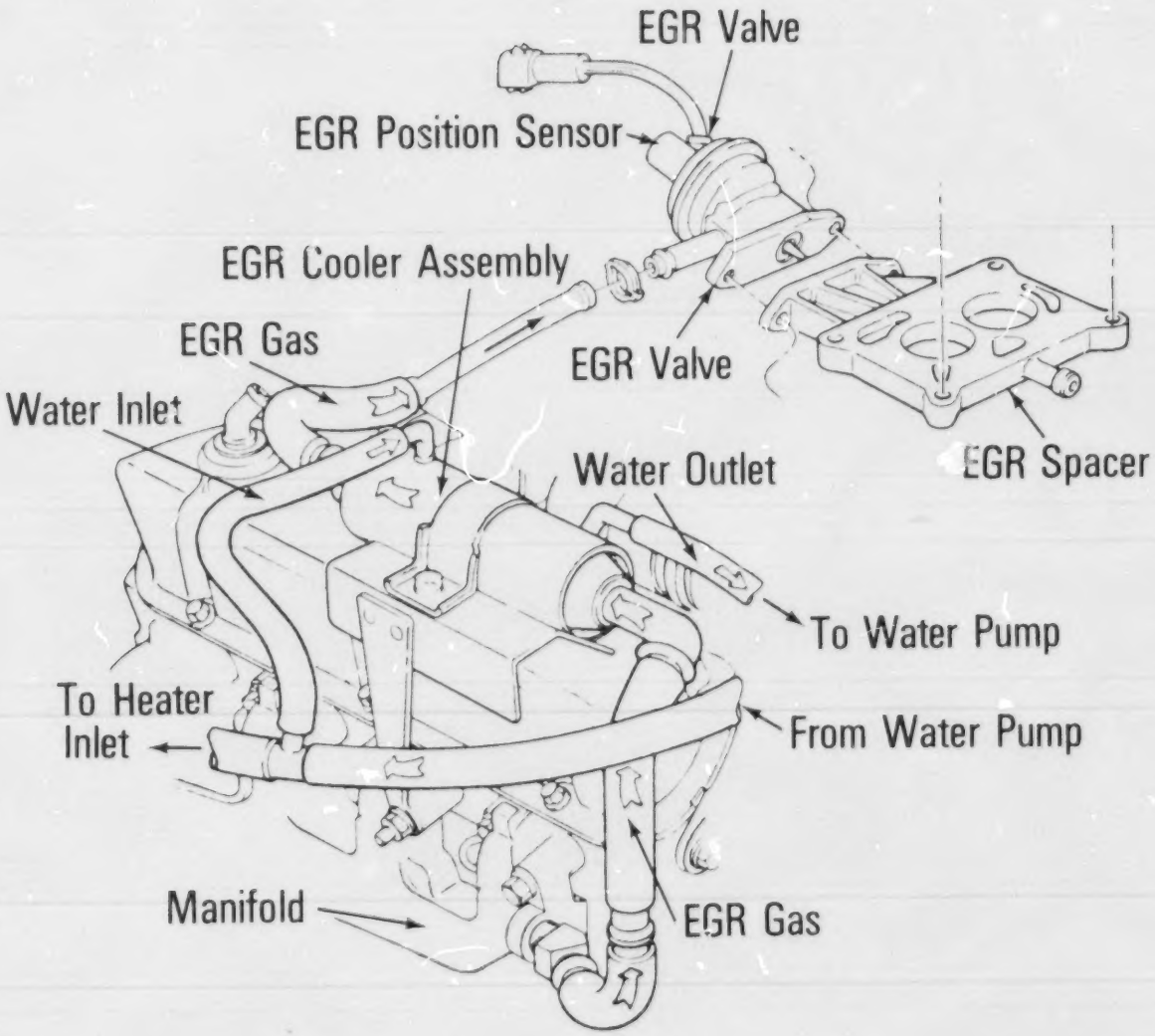
TM 4

AEC 229

Dual Diaphragm EGR Valve



EGR Cooler System



EXHAUST GAS RECIRCULATION SYSTEM
UNIT XI

JOB SHEET #1-CHECK THE PROPER OPERATION OF AND MAKE NECESSARY REPAIRS TO THE EGR SYSTEM

I. Tools and equipment

A. Tachometer

B. Appropriate hand tools

C. Protective gloves

II. Procedure

A. Inspect all hoses for cracks and connections for proper fit

B. Set parking brake and block drive wheels

C. Place transmission in neutral (standard) or in park (automatic)

D. Attach a tachometer to the engine

E. Start engine and adjust throttle to approximately 1,500 rpm

(NOTE: Steps F through I are used only to determine proper operation of the PVS. Proceed to step J to determine proper operation of the EGR valve for a quick check of the system or when the PVS is not suspect.)

F. Remove vacuum line to EGR valve from PVS and check to see that there is no vacuum

G. Replace vacuum hose and allow engine to warm to normal operating temperature

H. Remove the PVS hose and check for vacuum

(NOTE: There should be vacuum present when the engine is at operating temperatures. If not, the sensor unit must be replaced.)

I. Replace vacuum line

J. Accelerate the warm engine to approximately 2,000 rpm

K. Disconnect the vacuum line from the EGR valve

L. If engine RPM increases indicating proper operation, replace the vacuum hose

M. If engine RPM does not increase, but the valve moves, remove the EGR valve

JOB SHEET #1

N. Clean valve assembly and passages in manifold and replace unit

O. Repeat steps J and K to determine proper operation

P. Replace all hoses, shut off engine, and disconnect tachometer

(NOTE: On dual diaphragm EGR valves, some vibration of the valve stem will occur due to the modulation valve in the system. This is normal operation and does not require correction.)

EXHAUST GAS RECIRCULATION SYSTEM
UNIT XI

NAME _____

TEST

1. Match the components on the right to the correct functions.

_____ a.	Meters or regulates the amount of exhaust gas flow to the intake manifold	1. Single diaphragm EGR valve
_____ b.	A temperature actuated valve which controls vacuum flow from carburetor port to EGR valve according to engine sensor signals	2. Back pressure transducer valve
_____ c.	Slot like opening in the carburetor throttle body above the throttle plate in idle position which provides vacuum signal to system	3. EGR valve
_____ d.	Increases vacuum signal strength from carburetor timed vacuum port	4. Vacuum amplifier
_____ e.	Controlled only by signals from a vacuum source	5. Dual diaphragm EGR valve
_____ f.	Controlled by both vacuum signals and back pressure from exhaust system	6. EGR cooler
_____ g.	Regulates vacuum signal to EGR valve according to back pressure probe sensors in exhaust system	7. Timed vacuum port
_____ h.	Uses engine coolant to reduce and regulate recirculating exhaust gas temperature	8. Ported vacuum switch (PVS)

2. State the purpose of the exhaust gas recirculation (EGR) system.

3. Explain the operation of the exhaust gas recirculation system.

4. Demonstrate the ability to check the proper operation of and make necessary repairs to the EGR system.

   (NOTE: If this activity has not been accomplished prior to the test, ask your instructor when it should be completed.)

EXHAUST GAS RECIRCULATION SYSTEM
UNIT XI

ANSWERS TO TEST

1. a. 3
   b. 8
   c. 7
   d. 4
   e. 1
   f. 5
   g. 2
   h. 6

2. The purpose of the exhaust gas recirculation system is to meter exhaust gases to the air/fuel mixture.

3. Explanation should include:

   a. When the engine is first started and no vacuum is available, the EGR valve is held closed by the spring in the unit.

   b. When engine speed is increased and engine temperature increases to warm up the temperature controlled valve (PVS), vacuum is directed to the EGR valve

   c. The vacuum supply causes the diaphragm to lift the valve up to the open position

   d. Exhaust gases are metered through the EGR adapter plate and mixed with the air/fuel mixture

   e. As engine speed increases, under warm conditions, the man fold vacuum increases which causes the EGR valve to open more fully

   f. Under higher speed conditions, a cut off valve reduces manifold vacuum to the EGR valve which causes it to close

   g. Back pressure from the exhaust system is monitored to regulate the EGR valve

   h. As the engine shuts down, all components return to closed or "off" position

4. Performance skill evaluated to the satisfaction of the instructor.

POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the purpose of the positive crankcase ventilation (PCV) system. The student will also be able to explain the operation of the system and be able to visually inspect, test and service the system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Write the purpose of the positive crankcase ventilation (PCV) system.
2. Explain the operation of the positive crankcase ventilation system.
3. Demonstrate the ability to:
   a. Make a general test of the PCV system.
   b. Test the PCV system operation with a tachometer.

POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Closed PCV System
2. TM 2--PCV Valve Positions
3. TM 3--PCV Air Filter

D. Job sheets

1. Job Sheet #1--Make a General Test of the PCV System

2. Job Sheet #2--Test the PCV System Operation with Tachometer

E. Test

F. Answers to test

II. References

A. Chrysler Corporation. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Service Department, 1978.

B. *Vehicle Emission Control.* Detroit, Mich. Gargano Promotions, 1973.

C. Glenn, Harold T. *Glenn's Emission Control Systems.* Chicago, Ill.: Henry Regnery Co., 1972.

D. Patterson, D. J. and Henein, N. A. *Emissions from Combustion Engines and Their Control.* Ann Arbor, Michigan: Science Publishers, Inc., 1973.

E. Oldham, Joe and Forier, Lou. *Motor's Emission Control Manual.* New York, N.Y.

F. Ford Motor Company. *Vehicle Emission Control Systems.* Volume I, Detroit, Michigan: Service Publications/Helm Inc. (1978).

G. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

INFORMATION SHEET

I. Purpose of the positive crankcase ventilation system (PCV)--The purpose of the PCV system is to remove blow-by gases and crankcase vapors from the engine in order to prevent sludge formation and oil dilution

II. Operation of the positive crankcase ventilation system (Transparency 1)

(NOTE: Vapors which build up in the crankcase must be removed to prevent possible engine damage. In early model automobiles, draft tubes accomplished the purpose and were later converted to open PCV systems because of federal regulations. Today's automobiles use a closed PCV system to provide a more efficient operation. This description is of a closed system.)

A. During engine operation blow-by gases and oil vapors are accumulated in the crankcase

B. Fresh air is drawn into the crankcase through the oil filler cap from the air cleaner by a tube assembly (Transparency 3)

(NOTE: This air is filtered by the air cleaner filter or by a separate filter located on the inside of the air cleaner assembly.)

C. The fresh air mixes with the crankcase vapors and gases, then is drawn out through the rocker arm cover and directed to the intake manifold (Transparency 1)

D. The PCV control valve regulates the amount of vapor which enters the intake manifold (Transparency 2)

(CAUTION: When a PCV is replaced, the new valve must be matched with engine specifications according to manufacturer's instructions.)

(NOTE: Due to the precise air-fuel mixtures required by today's engines, the carburetors are calibrated to compensate for the PCV system. To accomplish this, the PCV valve is matched to the engine size. Otherwise the fuel mixtures would be inappropriate for proper engine operation.)

E. During engine idle conditions, the PCV valve is closed to restrict the amount of airflow from the crankcase so as not to overly dilute the air/fuel mixture

(NOTE: Under low speed operation with reduced manifold vacuum, a spring in the PCV valve partially opens the valve to allow more airflow from the crankcase.)

F. Under normal load with normal manifold vacuum, the PCV valve is fully opened to draw the maximum airflow from the crankcase

INFORMATION SHEET

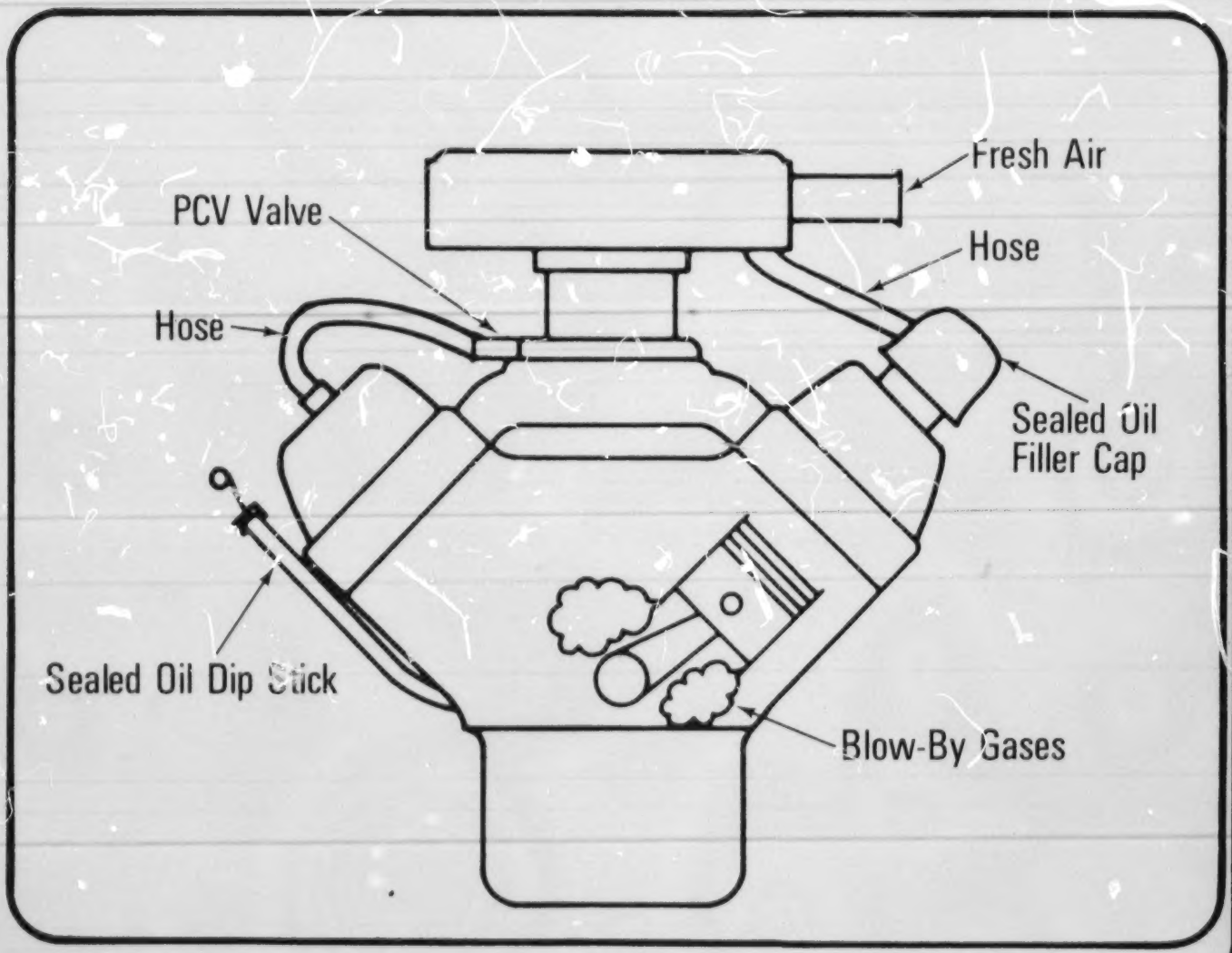
G. Under conditions of high manifold vacuum such as in deceleration, the spring tension is overcome and the PCV valve is closed

(NOTE: The valve is designed so that a small amount of airflow is drawn through it by means of a small orifice to allow crankcase ventilation at idle or deceleration when manifold vacuum is high. Some ventilation also occurs through the air cleaner hose under high speed conditions.)

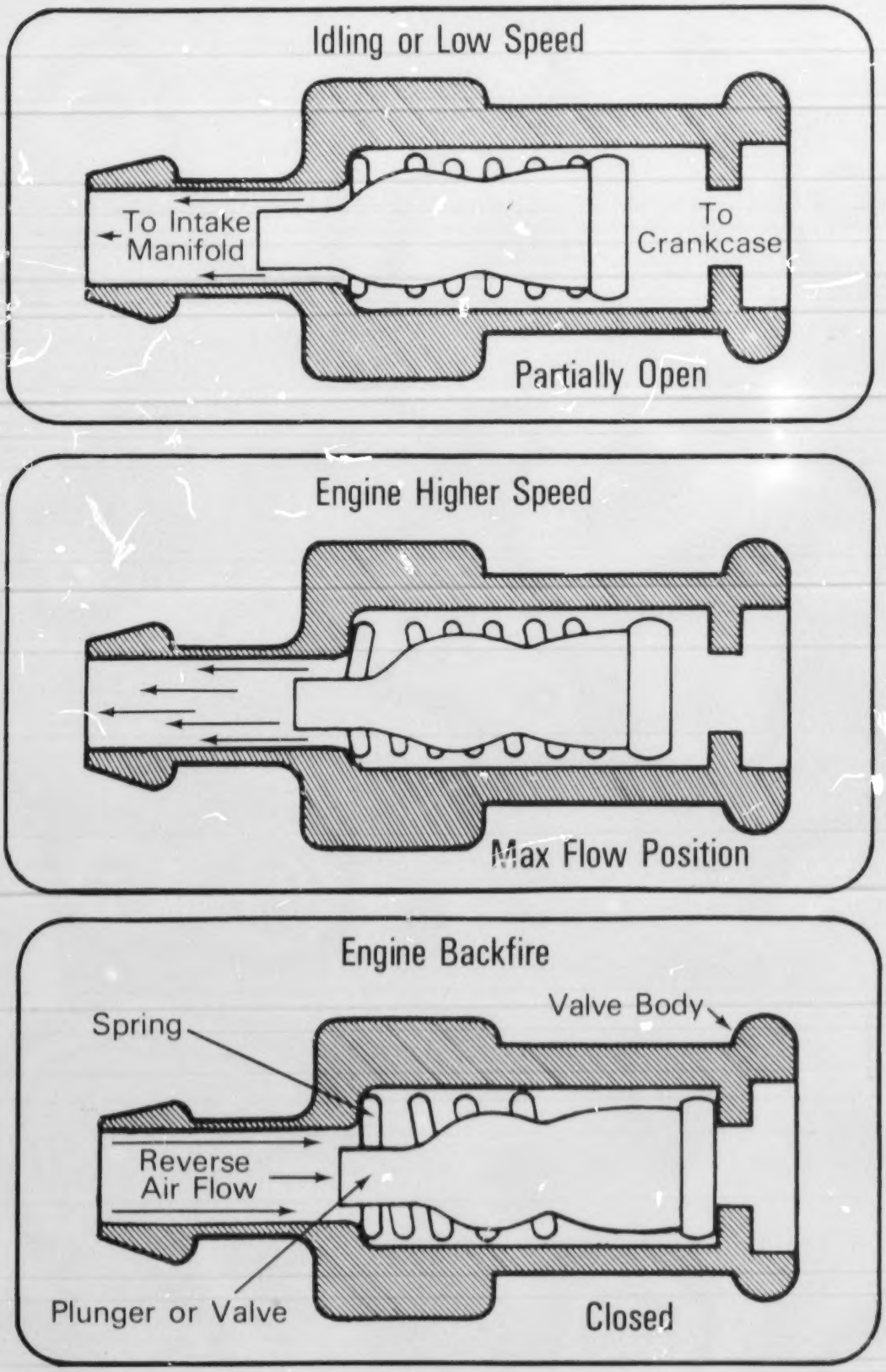
H. The PCV valve is fully closed during a backfire to prevent a possible explosion in the crankcase

(NOTE: This situation sets up a reverse condition or manifold pressure instead of vacuum that causes the valve to close. Gases and vapors in the crankcase are combustible so the ignition backfire could ignite them if the exhaust was allowed to enter.)

Closed PCV System

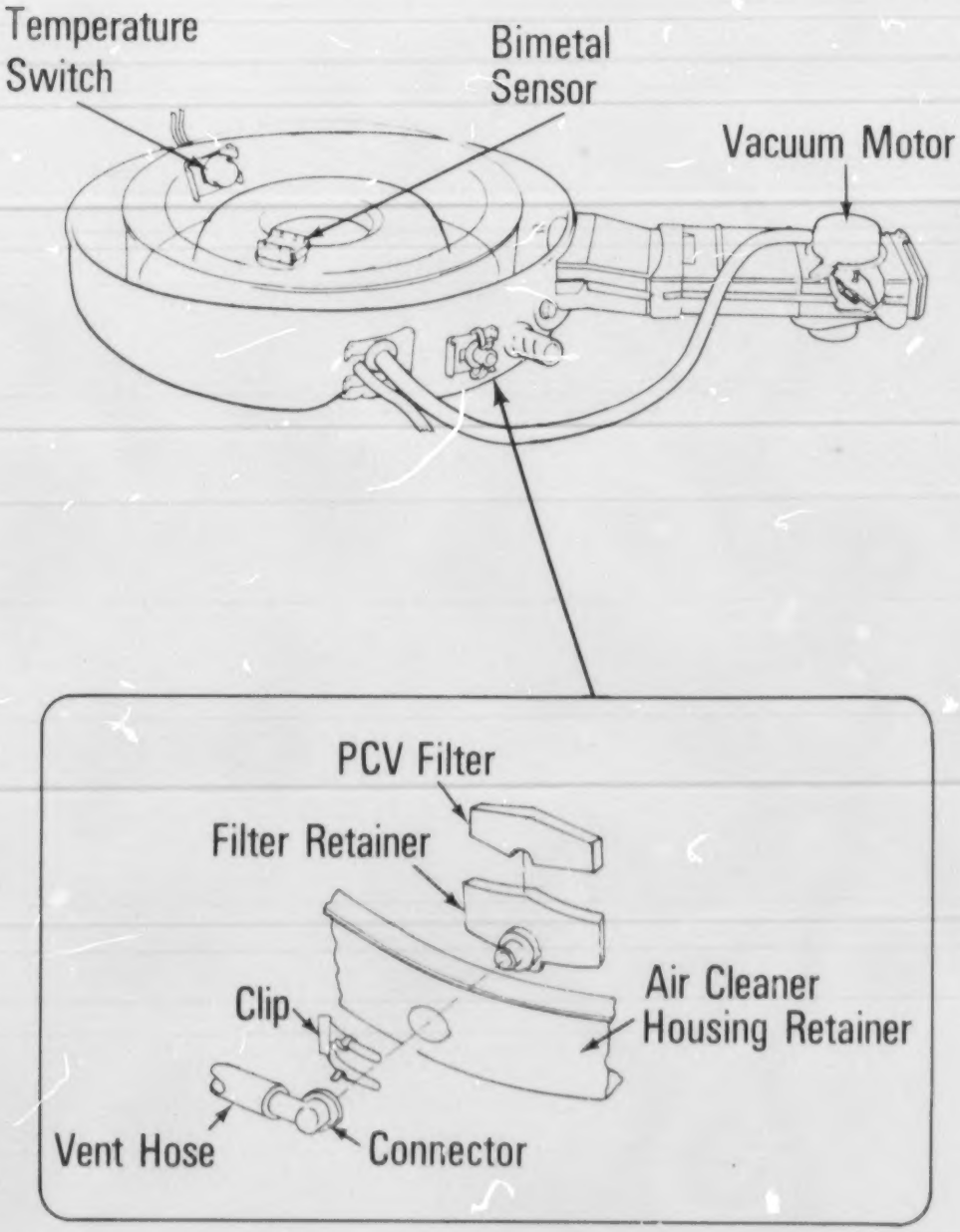


PCV Valve Positions



TM 2

PCV Air Filter



POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

JOB SHEET #1--MAKE A GENERAL TEST OF THE PCV SYSTEM

I. Tools required--Hand tools as needed

II. Procedure

A. Remove PCV valve

B. Shake PCV valve

(NOTE: A clicking noise should be heard.)

C. Reinstall valve in hose leading to intake manifold; leave other end of PCV valve disconnected

D. Start the engine

(NOTE: A distinct hissing noise should be heard.)

E. Place finger over the end of the PCV valve

(NOTE: A strong vacuum should be felt.)

F. Reinstall PCV valve

G. Remove oil filler cap

H. Hold a piece of fairly heavy paper next to the opening

(NOTE: It should be drawn down against the opening with noticeable force.)

I. Reinstall oil filler cap

J. Shut off engine

(NOTE: The preceding results show that the PCV valve is operating and the system hoses are clear.)

(CAUTION: If replacement of PCV valve is required, be certain to use the correct model to assure proper performance.)

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service shop manual or technical manual for exact procedures for each make and model.)

POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

JOB SHEET #2--TEST THE PCV SYSTEM OPERATION WITH A TACHOMETER

I. Tools required--Tachometer

II. Procedure

A. Connect tachometer to the engine

B. Start the engine

C. Clamp off the hose between the PCV valve and the intake manifold

D. If the system is operating correctly, a drop of 40-80 rpm will be seen on the tachometer

E. No change in rpm indicates a sticking PCV valve, plugged hoses, or dirty PCV filter

F. A drop in engine rpm, in excess of 80 rpm, indicates that the wrong PCV valve for that engine has been installed

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service shop manual or technical manual for exact procedures for each make and model.)

POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

NAME _____

TEST

1. Write the purpose of the positive crankcase ventilation (PCV) system.

2. Explain the operation of the positive crankcase ventilation system.

3. Demonstrate the ability to:

   a. Make a general test of the PCV system.

   b. Test the PCV system operation with a tachometer.

(NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

POSITIVE CRANKCASE VENTILATION SYSTEM
UNIT XII

ANSWERS TO TEST

1. The purpose of the PCV system is to remove blow-by gases and crankcase vapors from the engine in order to prevent sludge formation and oil dilution

2. Explanation should include:

   a. During engine operation blow-by gases and oil vapors are accumulated in the crankcase

   b. Fresh air is drawn into the crankcase through the oil filler cap from the air cleaner by the tube assembly

   c. The fresh air mixes with the crankcase vapors and gases, then is drawn out through the rocker arm cover and directed to the intake manifold

   d. The PCV control valve regulates the amount of vapor which enters the intake manifold

   e. During engine idle conditions, the PCV valve is closed to restrict the amount of airflow from the crankcase so as not to overly dilute the air/ fuel mixture

   f. Under normal load with normal manifold vacuum, the PCV valve is fully opened to draw the maximum airflow from the crankcase

   g. Under conditions of high manifold vacuum such as in deceleration, the spring tension is overcome and the PCV valve is closed

   h. The PCV valve is fully closed during a backfire to prevent a possible explosion in the crankcase

3. Performance skills evaluated to the satisfaction of the instructor

AIR INJECTION SYSTEM
UNIT XIII

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the purpose of the air injection system. The student should also be able to inspect, test, and repair components of the system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match parts associated with the air injection system to their correct functions.
2. State the purpose of the air injection system.
3. Explain the operation of the air injection system.
4. List the functions of the diverter (air by-pass) valve.
5. Distinguish between the functions and effects of valves which control the diverter valve.
6. List the six major components of computer controlled (electronic) systems.
7. List the three components of the pulse air injection system.
8. Explain the operation of the pulse air injection system.
9. Demonstrate the ability to:
   a. Inspect air manifold and hoses.
   b. Inspect drive belt and set correct tension.
   c. Check air pump output.
   d. Check diverter valve operation.
   e. Inspect check valve operation.
   f. Check vacuum differential valve operation.
   g. Check proper operation of auxiliary control mechanisms.

AIR INJECTION SYSTEM
UNIT XIII

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined on job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet.

B. Information sheet.

C. Transparency masters

1. TM 1--Air Injection System
2. TM 2--Types of Diverter Valves
3. TM 3--Diverter Valve Operation
4. TM 4--Air Manifold and Check Valve Assembly

5. TM 5--Auxiliary Systems
6. TM 6--Pulsed Air System
7. TM 7--Electronic Engine Control (EEC) Ford System
8. TM 8--Computer Controlled Catalytic Converter GM (C-4) System

D. Job sheets

1. Job Sheet #1--Inspect Air Manifold and Hoses
2. Job Sheet #2--Inspect Drive Belt and Set Correct Tension
3. Job Sheet #3--Check Air Pump Output
4. Job Sheet #4--Check Diverter Valve Operation
5. Job Sheet #5--Inspect Check Valve Operation
6. Job Sheet #6--Check Vacuum Differential Valve Operation
7. Job Sheet #7--Check Proper Operation of Auxiliary Control Mechanism

E. Test

F. Answers to test

II. References:

A. Chrysler Corporation. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Chrysler Corporation/Service Department, 1978.

B. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

C. Ford Motor Company. *Vehicle Emission Control Systems.* Volumes 1 and II, Detroit, Michigan: Service Publications/Helm Inc., 1978.

D. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1979.

E. General Motors Corporation. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

F. General Motors Corporation. *1980 Phoenix Service Manual.* Pontiac, Michigan: Pontiac Motor Division, 1979.

G. Glenn, Harold T. *Glenn's Emission Control Systems.* Chicago, Ill., Henry Regnery Co., 1972.

H. Joe Oldham and Lou Forier, *Motor's Emission Control Manual.* New York, N. Y.: Motor.

AIR INJECTION SYSTEM
UNIT XIII

INFORMATION SHEET

I. Parts and functions

(NOTE: Not all systems use every component described below.)

A. Air pump--Supplies filtered air to the air injection system (Transparency 1)

B. Check valve--Prevents exhaust gases from entering the pump assembly (Transparency 4)

C. Air injection manifold--Tube like device which distributes compressed air to the exhaust system (Transparency 4)

D. Air injection tube (nozzle)--Directs air from air injection manifold into exhaust port

E. Diverter (air by-pass) valve--Controls the supply of injected air to system or to atmosphere according to engine conditions (Transparency 1)

F. Vacuum differential valve--Controls vacuum supply to the diverter valve (Transparency 5)

G. Solenoid vacuum valve--Controls vacuum supply to vacuum differential valve according to various temperature sensors (Transparency 5)

H. Floor pan switch--Senses temperature of floor of automobile (Transparency 5)

I. Air cleaner temperature switch--Senses engine compartment temperature (Transparency 5)

J. Ported vacuum switch (PVS)--Senses engine coolant temperature (Transparency 5)

K. Pressure relief valve--Relieves excessive system pressure caused by air pump at high engine speeds or system restrictions (Transparency 2)

L. Air supply valve--Directs secondary (injected) air to the exhaust manifold or the catalytic converter (Transparency 7)

II. Purpose of the air injection system--The purpose of the air injection system is to supply air to the exhaust system in order to continue the combustion process and reduce hydrocarbon emissions

INFORMATION SHEET

III. Operation of the air injection system

A. When the engine is started the air pump compresses and discharges air to the diverter valve

B. Manifold vacuum opens the diverter valve where the air is metered and sent to the air injection manifolds

C. A check valve in each air injection manifold allows compressed air to flow into the exhaust port but prevents return of the air and gases to the diverter valve

D. Injected air is mixed with exhaust gases to continue the combustion process of unburned hydrocarbons

IV. Functions of the diverter (air by-pass) valve (Transparency 3)

A. Provides pressure relief to the system caused by:

1. Excess pump volume

2. Restrictions in the hoses and systems tubing

B. Dumps pump output to the atmosphere under the following conditions:

1. Engine deceleration

2. When engine coolant temperature is below normal operating level

3. When engine coolant temperature is above normal operating level

4. When the floor pan temperature is above normal operating level

V. Functions and effects of the valves which control the diverter valve

A. Vacuum differential valve (VDV)

1. Function--Senses a vacuum pressure change under deceleration which causes the valve to dump all vacuum and prevent it from going to the diverter valve

2. Effects

a. Diverter valve closes to prevent compressed air from entering exhaust distribution system

b. Air is diverted to atmosphere through the muffler in the diverter valve until vacuum is restored by the VDV

INFORMATION SHEET

B. Solenoid vacuum valve

1. Function--Closes off vacuum supply to the VDV when electrical signals are received from the ported vacuum switch, the air cleaner temperature switch, or the floor pan switch

2. Effects--Diverter valve responds to vacuum signals to dump compressed air as needed

(NOTE: Under periods of long idle, engines tend to overheat due to ignition, carburetor, and other emission modifications. Engine coolant temperature sensors prevent excessive overheating by providing signals to engine controls. The catalytic converter also overheats during prolonged idle due to higher exhaust gas temperature. To prevent overheating, the diverter valve dumps the air when signals from the floor pan switch are sent to the solenoid vacuum valve.)

VI. Components of computer controlled (electronic) system (Transparencies 7 and 8)

A. Exhaust gas oxygen sensor

B. Electronic control module

C. Variable ratio carburetor

D. Three way catalytic converter

E. Throttle switch

F. Air supply valve

(NOTE: Some models use some but not all of the components listed. Some models divert injected air into the catalytic converter when engine temperature is normal and through exhaust manifold when temperature is below normal.)

VII. Components of the pulse air injection system (Transparency 6)

(NOTE: This system is used in some small 4 and 6 cylinder applications in place of the air pump method.)

A. Pulse air valve assembly

B. Check valves (located in valve assembly)

C. Connecting tubes

INFORMATION SHEET

VIII. Operation of the pulse air injection system

A. The check valves are connected to separate exhaust ports by pipes

B. Air is drawn in through the check valves as exhaust manifold pressure changes at each port

(NOTE: When the engine fires, a pulsating effect is created in the exhaust ports. This pulsating effect alternates negative pressure with exhaust pressure.)

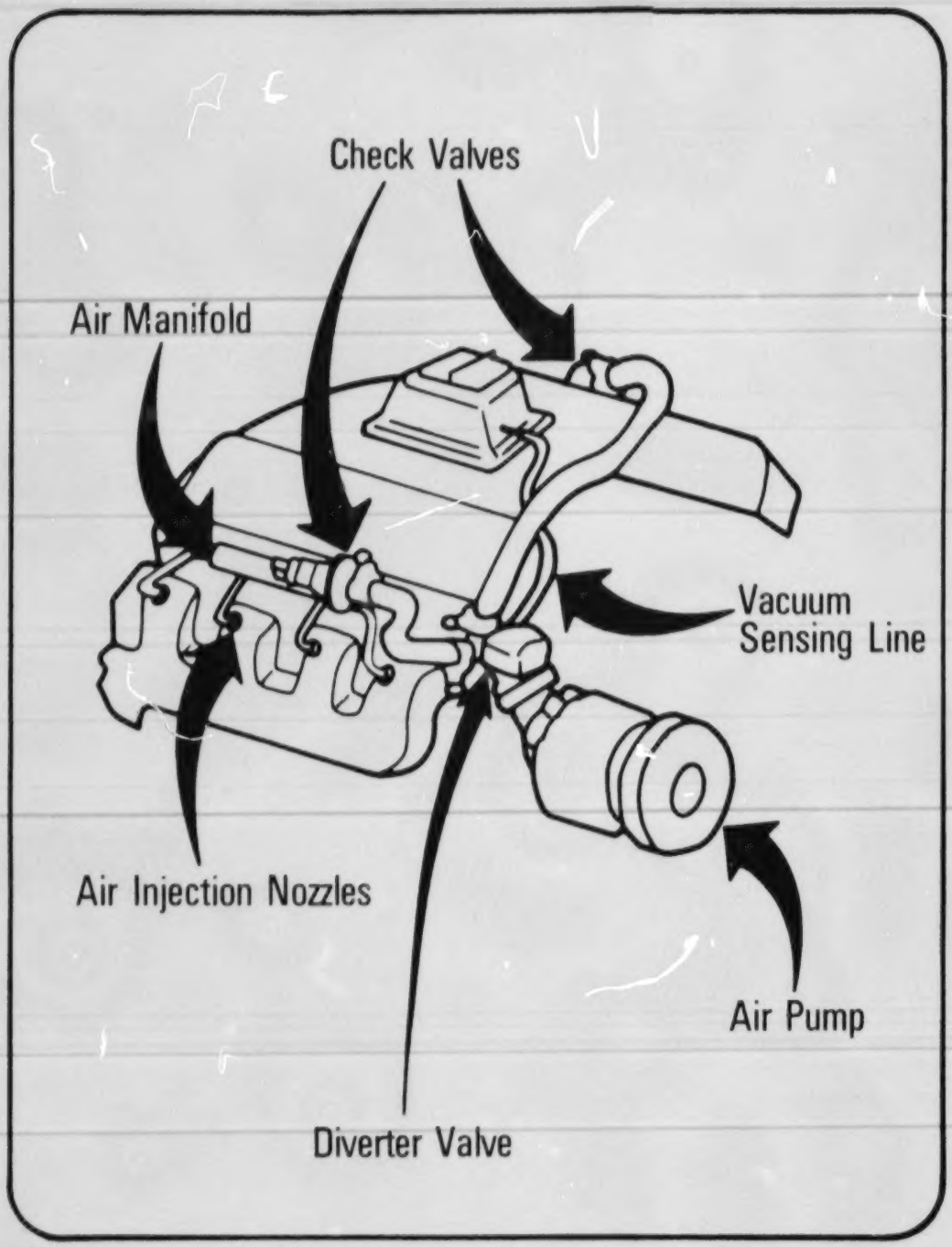
C. The negative pressure or vacuum created at the exhaust port allows fresh air to mix with exhaust gases in the exhaust manifold

D. Exhaust gases continue the combustion process to reduce hydrocarbon emissions

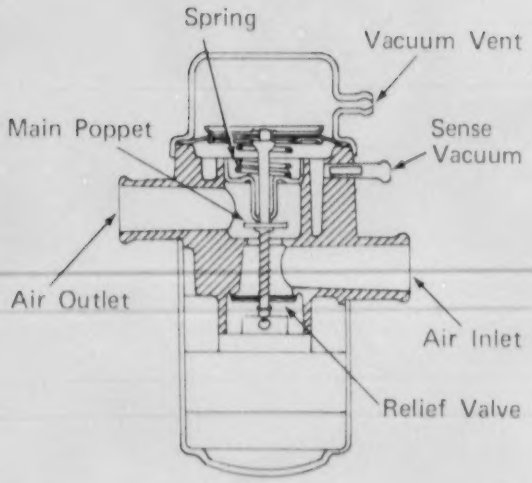
E. When positive pressure is present, the check valve closes and burned gases are exhausted through the system as normal

F. The process is repeated for each cylinder to serve the same purpose as injected air methods

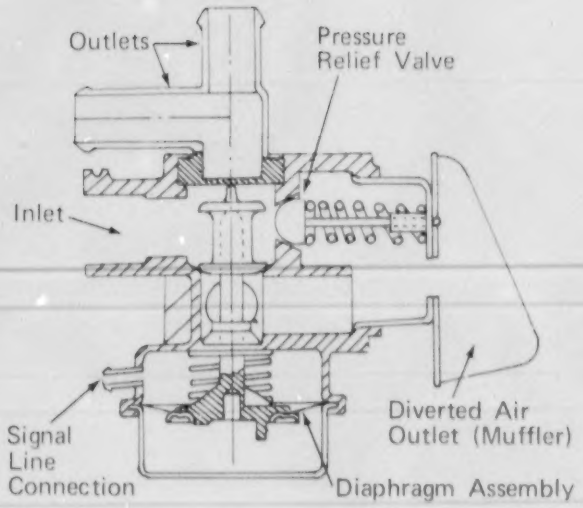
Air Injection System



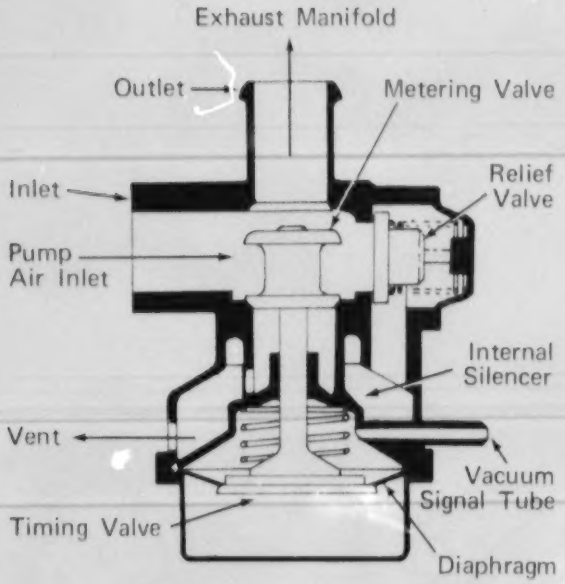
Types of Diverter Valves

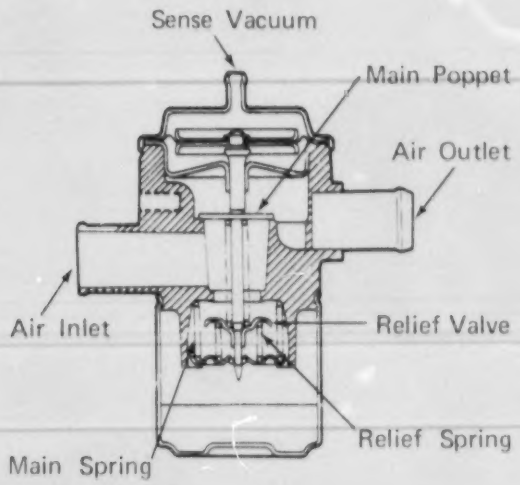


Timed Type With Vacuum Vent



External Muffler Type

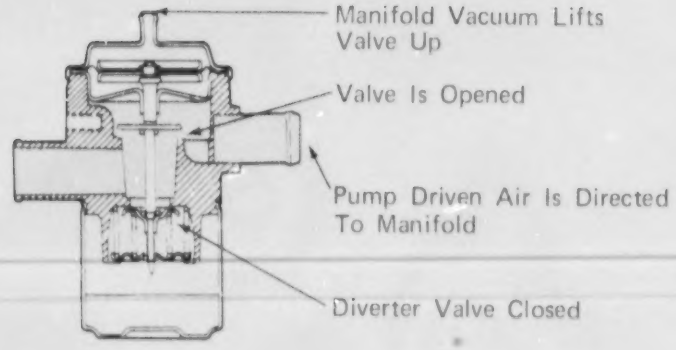




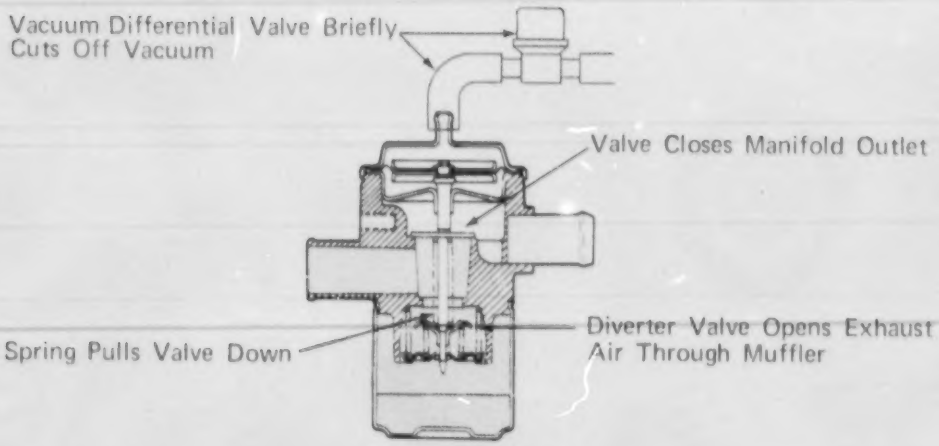
Internal Muffler Type

Diverter Valve Operation

Normal Operation

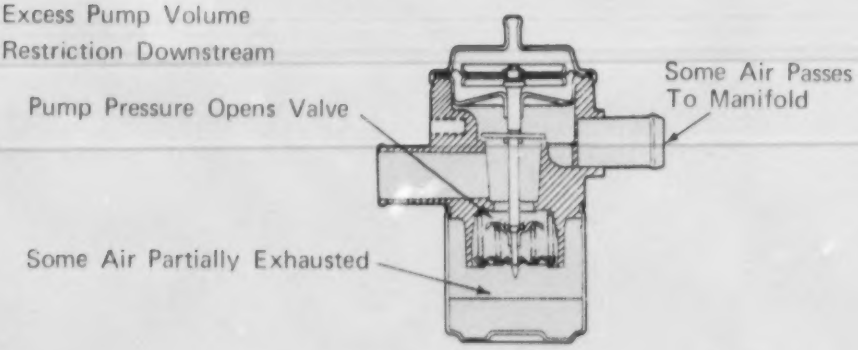


Deceleration or Vacuum Interruption

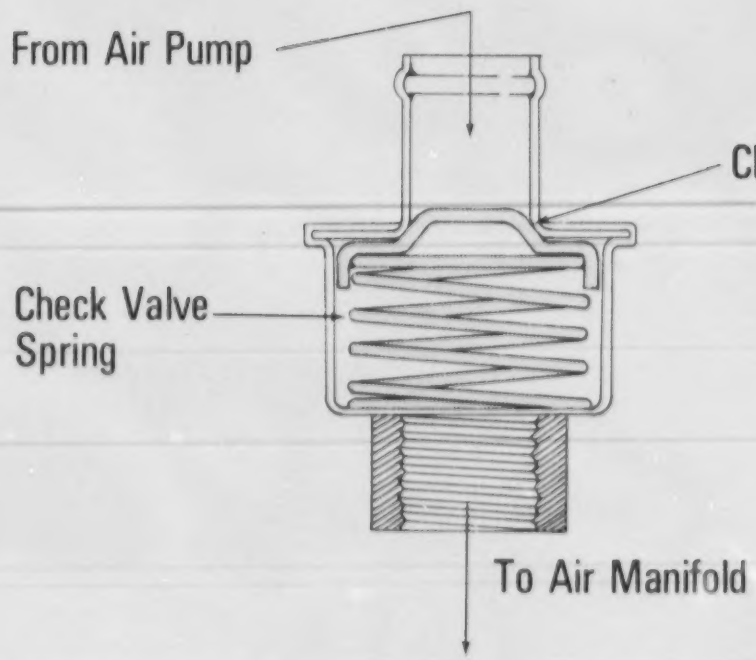

Vacuum Differential Valve Briefly Cuts Off Vacuum
Valve Closes Manifold Outlet
Spring Pulls Valve Down
Diverter Valve Opens Exhaust Air Through Muffler

Pressure Relief

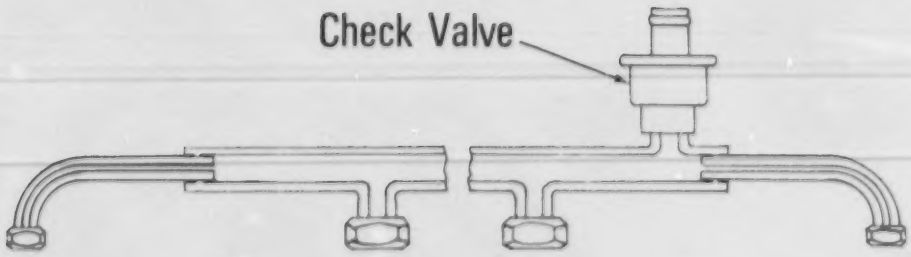
- Excess Pump Volume
- Restriction Downstream



Air Manifold and Check Valve Assembly

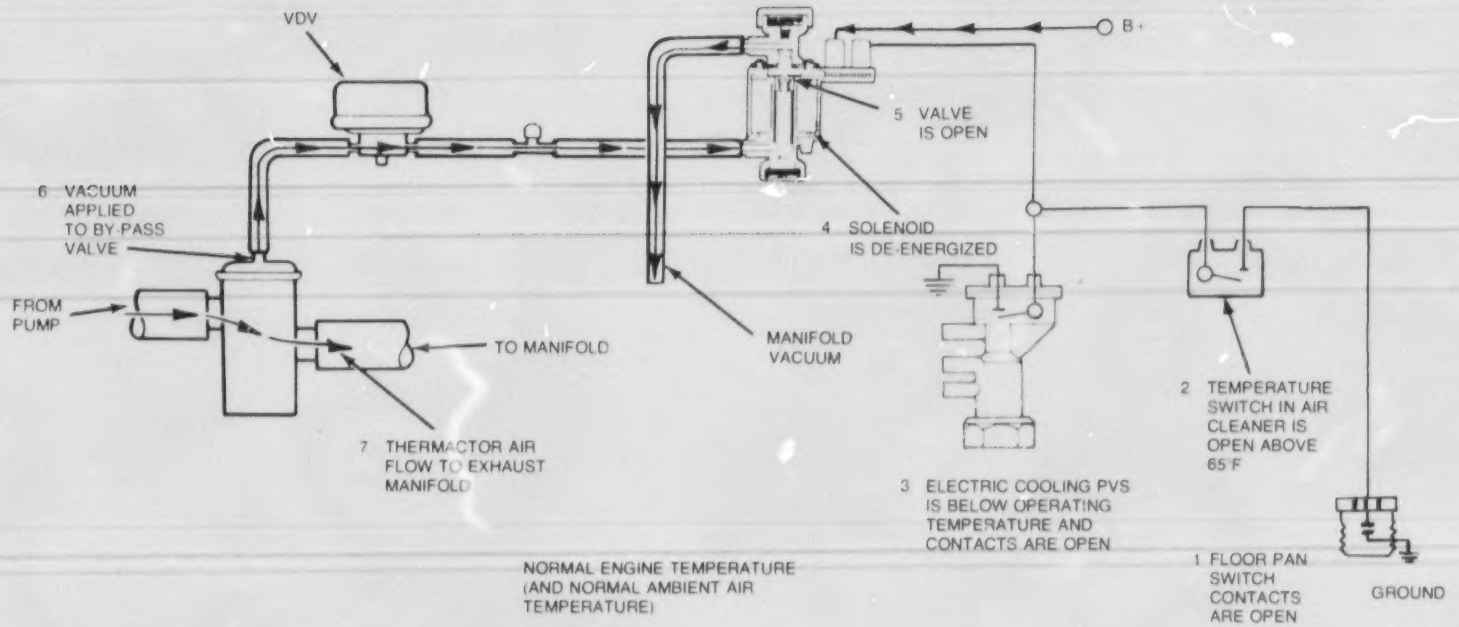


Check Valve Assembly

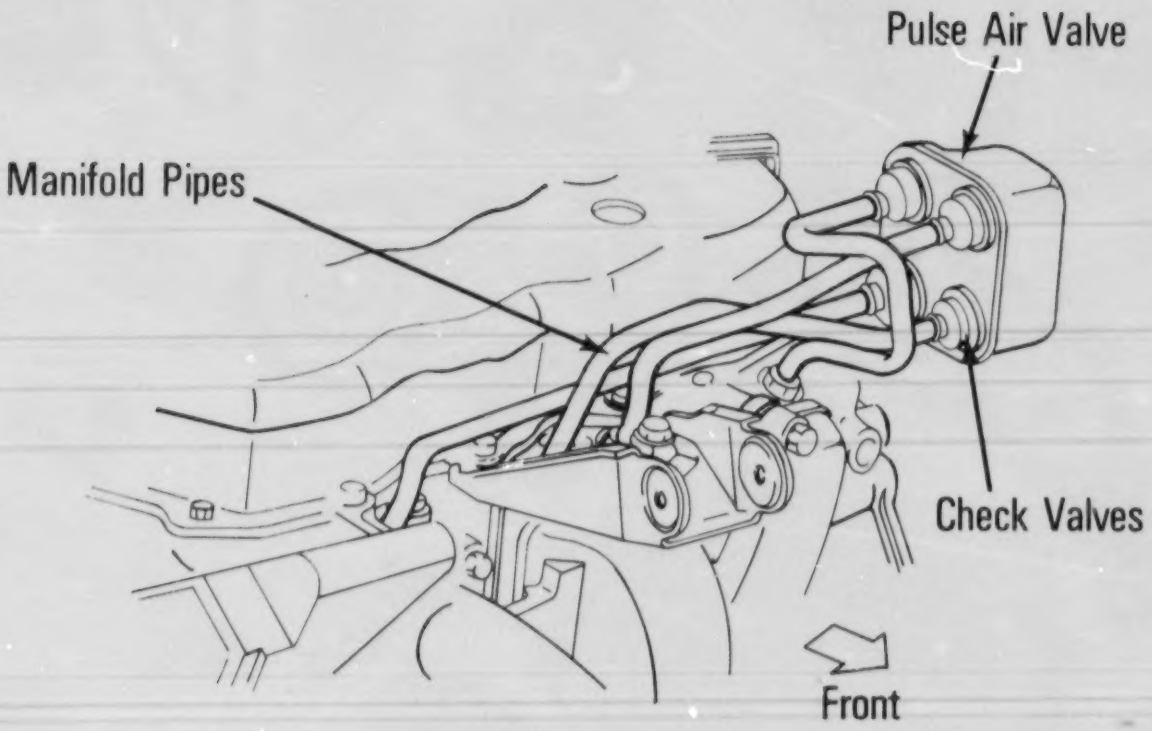


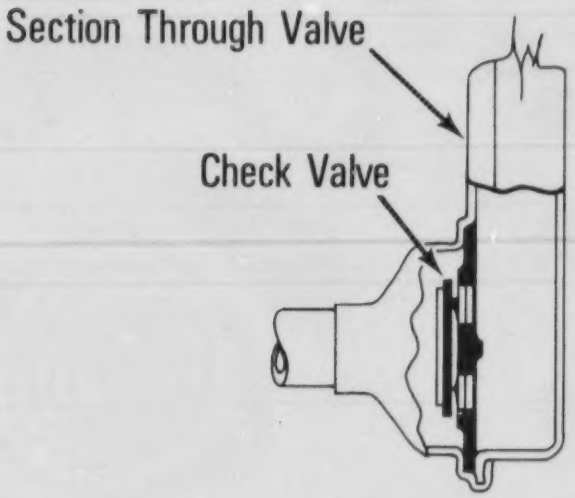
Air Manifold

Auxiliary Systems

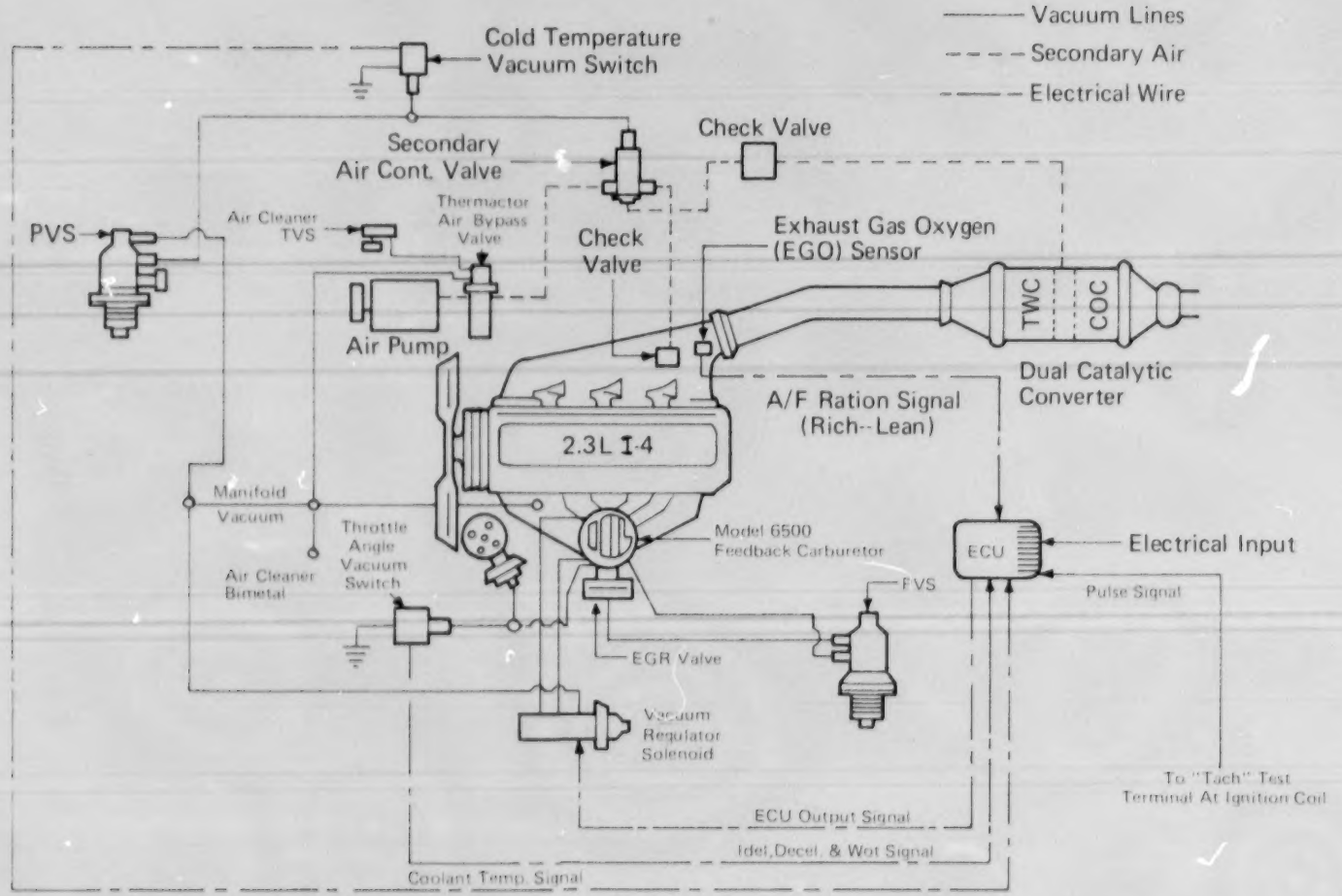

VDV
B+
5 VALVE IS OPEN
6 VACUUM APPLIED TO BY-PASS VALVE
4 SOLENOID IS DE-ENERGIZED
FROM PUMP
TO MANIFOLD
MANIFOLD VACUUM
7 THERMACTOR AIR FLOW TO EXHAUST MANIFOLD
2 TEMPERATURE SWITCH IN AIR CLEANER IS OPEN ABOVE 65 F
3 ELECTRIC COOLING PVS IS BELOW OPERATING TEMPERATURE AND CONTACTS ARE OPEN
NORMAL ENGINE TEMPERATURE (AND NORMAL AMBIENT AIR TEMPERATURE)
1 FLOOR PAN SWITCH CONTACTS ARE OPEN
GROUND

Pulsed Air System

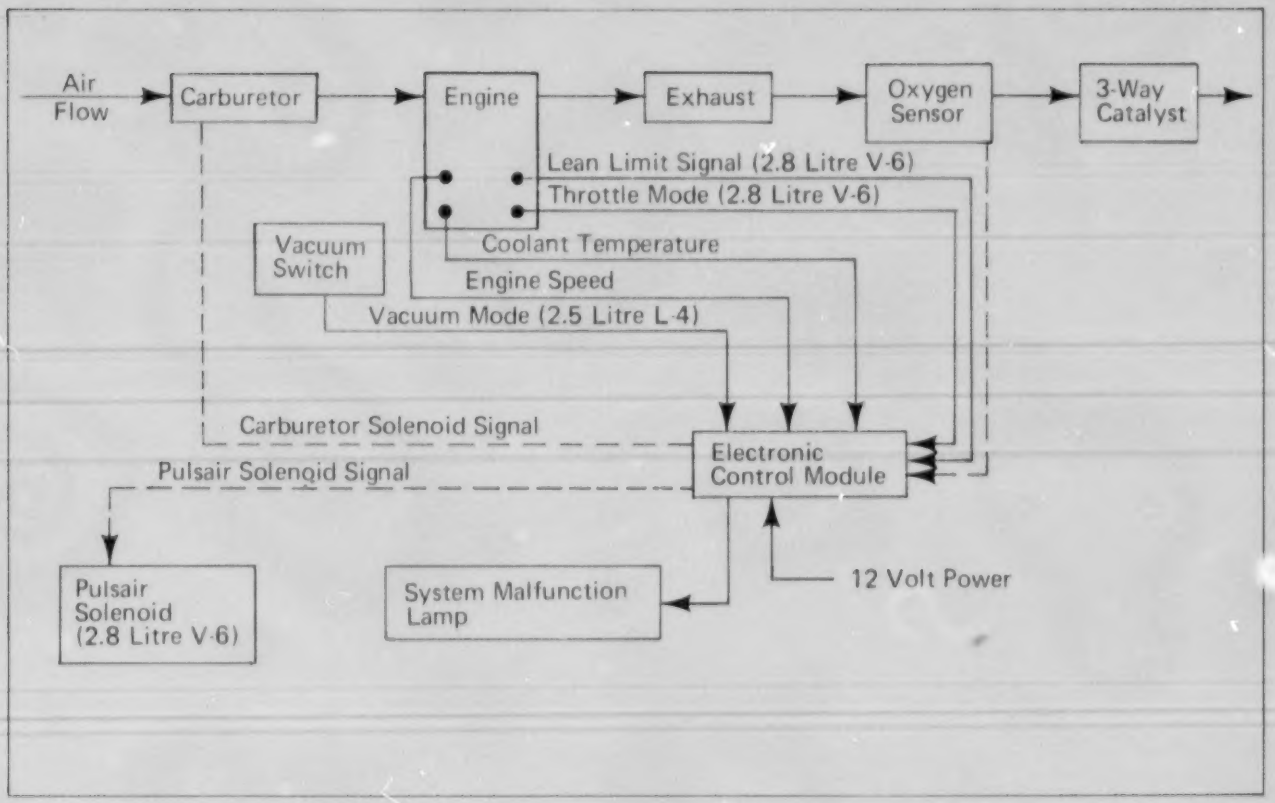


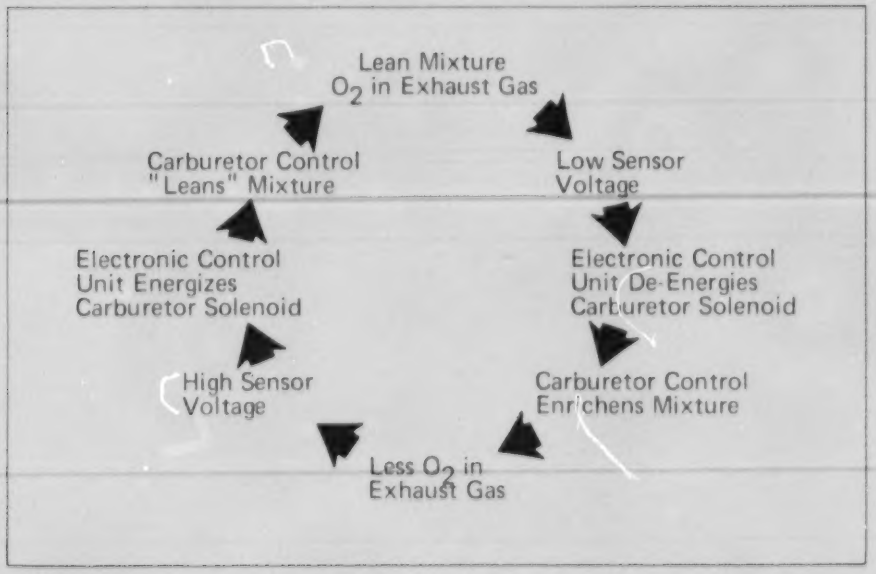


Electronic Engine Control--(EEC)
Ford System



Computer Controlled Catalytic Converter GM (C-4) System




Lean Mixture
O_2 in Exhaust Gas
Carburetor Control "Leans" Mixture
Low Sensor Voltage
Electronic Control Unit Energizes Carburetor Solenoid
Electronic Control Unit De-Energies Carburetor Solenoid
High Sensor Voltage
Carburetor Control Enrichens Mixture
Less O_2 in Exhaust Gas

TM 8

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #1--INSPECT AIR MANIFOLD AND HOSES

I. Tools required--Hand tools as needed

II. Procedure

A. Inspect air manifold for holes and fractures

B. Inspect air hoses for cracks, deterioration, holes and routing (no kinks or sharp bends)

C. Inspect and check all hose and manifold connections for tightness

(NOTE: Soapy water can be used to check connections.)

(CAUTION: DO NOT GET ANY WATER NEAR A TWO VANE PUMP CENTRIFUGAL FILTER. THIS CAN DESTROY THE PUMP.)

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service shop manual or technical manual for exact procedures for each make and model.)

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #2--INSPECT DRIVE BELT AND SET CORRECT TENSION

I. Tools required

A. Hand tools as needed

B. Pry bar

C. Belt tension gauge

II. Procedure

A. Turn belt over and visually inspect for wear, cracks and deterioration.

(NOTE: Replace if necessary.)

B. Check appropriate service manual for correct belt tension setting

C. Using belt tension gauge, check belt tension

D. If tension of belt must be reset, loosen appropriate bolt(s)

E. Move pump outward to establish proper belt tension

(CAUTION: Do not use pry bar against the pump body as this can cause internal damage to the pump assembly

(NOTE: Check manufacturer's recommendations for location to place pry bar or use special tool designed by the manufacturers for this purpose.)

F. Tighten bolt(s) which were loosened in step D

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service shop manual or technical manual for exact procedures for each make and model.)

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #3 CHECK AIR PUMP OUTPUT

I. Tools required--Hand tools as needed

II. Procedure

A. Loosen clamp and remove one outlet hose from diverter valve

B. Start the engine

C. Check the air flow from the outlet on the diverter valve

D. Accelerate engine to approximately 1500 rpm

(NOTE: Air flow should increase as engine speed increases.)

E. If air flow does not increase, check for air flow out of the diverter valve muffler

F. Shut off engine

G. Reconnect hose

H. Tighten clamp

I. Start engine and check for air leaks on reconnected hose

(NOTE: These are BASIC PROCEDURES. Check the manufacturer's service manual or technical manual for exact procedures for each make and model.)

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #4--CHECK DIVERTER VALVE OPERATION

I. Tools--Shop tools as required

II. Procedure

A. Warm engine to operating temperature

B. Disconnect vacuum hose from diverter valve

C. Check for vacuum by placing finger over the end of the hose

D. Reconnect vacuum hose to diverter valve

E. Check diverter valve muffler to determine if air is escaping

(NOTE: There should be no air escaping under normal conditions. A restriction in the tubing or air lines will cause the relief valve to open and discharge air through the muffler.)

F. If air is escaping, check all lines for kinks and/or binds

G. Make the necessary repairs to remove the obstruction

H. Place hand by diverter valve

I. Quickly open and close the throttle

J. Determine if air is released through the muffler for a brief period when the throttle is closed

K. A blast of air indicates the valve is functioning properly

(NOTE: These are BASIC PROCEDURES. For exact procedures, check manufacturer's manual.)

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #5--INSPECT CHECK VALVE OPERATION

I. Tools

Shop tools as required

II. Procedure

A. Disconnect air hose from diverter at the check valve connection(s).

B. Remove check valve from air injection manifold(s).

(NOTE: Be careful not to bend the air manifold when removing the valve.)

C. Blow through the valve in the direction of normal air flow

D. Reverse the valve and try to blow against the valve assembly

E. If air flow is not restricted in step C but is restricted in Step D, valve operation is normal

F. If air flow can be made through the reverse position, replace the defective valve

G. Reinstall the valve in the air manifold(s)

H. Reconnect the air line(s)

I. Check for air leaks according to normal procedures

(NOTE: These are BASIC PROCEDURES. For exact procedures, check manufacturer's manual.)

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #6 CHECK VACUUM DIFFERENTIAL VALVE OPERATION

I. Tools

Shop tools as needed

II. Procedures

A. Warm engine to normal operating temperature

B. Disconnect air hose from diverter valve to air manifold

C. Check for vacuum to the VDV by removing vacuum hose from vacuum input side of the valve

D. Reconnect vacuum hose to valve

E. With transmission in neutral or park, increase engine speed and quickly close throttle

F. Determine if air output from diverter valve changes from hose outlet to muffler or by-pass outlet for a brief period

G. If no change is noticed, replace VDV

H. Repeat steps E and F if VDV is replaced

I. Stop engine and reconnect air hose to diverter valve

J. Start engine and check for air leaks according to suggested procedures

(NOTE: These are BASIC PROCEDURES. For exact procedures check manufacturer's manual.)

AIR INJECTION SYSTEM
UNIT XIII

JOB SHEET #7 CHECK PROPER OPERATION
OF AUXILIARY CONTROL MECHANISMS

I. Tools

A. Shop tools as needed

B. Electrical leads

II. Procedure

(NOTE: The main control valve is generally an electric solenoid which closes off vacuum to the diverter valve on response to electrical signals. These signals come from temperature or speed sensors located in various parts of the chassis and engine.)

A. Start the engine and warm to operation temperature

B. Disconnect vacuum hoses from solenoid vacuum valve

C. Energize the valve by directly connecting it to an electrical source in the engine compartment

D. Hold finger over vacuum outlet from solenoid valve and reconnect vacuum hose from intake manifold to the valve

E. If no vacuum is felt, replace the valve assembly and repeat steps C & D

F. Replace vacuum hoses

G. Remove external electrical source

H. Check operation of each of the other auxiliary controls

(NOTE: The following procedure is used for each switch or sensor which sends electrical signals to the solenoid vacuum valve. The steps are repeated for each electrical connection from the sensors.)

1. Disconnect vacuum hose from solenoid to VDV at the VDV

2. Place finger over the end of the vacuum hose

3. Disconnect the electrical wiring from the sensor to solenoid wiring at sensor attachment

(NOTE: This can be done at the sensor [switch] or at electrical modulator or amplifier if so equipped.)

JOB SHEET #7

4. If no vacuum is felt, switch is functioning properly

5. If vacuum is feit, replace switch

6. Reconnect the wiring

(NOTE: The switches can also be checked by using a self-power test light if desired. This procedure will confirm suspected broken or loose wiring conditions.)

AIR INJECTION SYSTEM
UNIT XIII

NAME _____

TEST

1. Match the parts on the right to the correct functions.

_____a.	Supplies filtered air to the air injection system	1. Ported vacuum switch (RVS)
_____b.	Prevents exhaust gases from entering the pump assembly	2. Air injection tube (nozzle)
_____c.	Tube like device which distributes compressed air to the exhaust system	3. Solenoid vacuum valve
_____d.	Directs air from the air injection manifold into the exhaust port	4. Air pump
_____e.	Controls the supply of injected air to system or to atmosphere according to engine conditions	5. Floor plan switch
_____f.	Controls vacuum supply to the diverter valve	6. Pressure relief valve
_____g.	Controls vacuum supply to vacuum differential valve according to various temperature sensors	7. Check valve
_____h.	Senses temperature of floor of automobile	8. Diverter (air by-pass) valve
_____i.	Senses engine compartment temperature	9. Air supply valve
_____j.	Senses engine coolant temperature	10. Air cleaner temperature switch
_____k.	Relieves excessive system pressure caused by air pump at high engine speeds or system restrictions	11. Vacuum differential valve
_____l.	Directs secondary (injected) air to the exhaust manifold or the catalytic converter	12. Air injection manifold

2. State the purpose of the air injection system.

3. Explain the operation of the air injection system.

4. List the functions of the diverter (air by-pass) valve.

   a.

      1)

      2)

   b.

      1)

      2)

      3)

      4)

5. Distinguish between the functions and effects of the vacuum differential valve and the solenoid vacuum valve by placing an "X" next to the functions and effects of the solenoid vacuum valve.

   _____a. 1) Function--Closes off vacuum supply to the VDV when electrical signals are received from the ported vacuum switch, the air cleaner temperature switch, or the floor pan switch

      2) Effects--Diverter valve responds to vacuum signals to dump compressed air as needed

   _____b. 1) Function--Senses a vacuum pressure change under deceleration which causes the valve to dump all vacuum and prevent it from going to the diverter valve

      2) Effects

         a. Diverter valve closes to prevent compressed air from entering exhaust distribution system

         b. Air is diverted to atmosphere through the muffler in the diverter valve until vacuum is restored by the VDV

6. List six major components of the computer controlled (electronic) system.

   a.

   b.

   c.

   d.

   e.

   f.

7. List three components of the pulse air injection system.

   a.

   b.

   c.

8. Explain the operation of the pulse air injection system.

9. Demonstrate the ability to:

   a. Inspect air manifold and hoses.

   b. Inspect drive belt and set correct tension.

   c. Check air pump output.

   d. Check diverter valve operation.

   e. Inspect check valve operation.

   f. Check vacuum differential valve operation.

   g. Check proper operation of auxiliary control mechanisms.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

AIR INJECTION SYSTEM
UNIT XIII

ANSWERS TO TEST

1.	a.	4	d.	2	g.	3	j.	1
	b.	7	e.	8	h.	5	k.	6
	c.	12	f.	11	i.	10	l.	9

2. The purpose of the air injection system is to supply air to the exhaust system in order to continue the combustion process and reduce hydrocarbon emissions

3. Explanation should include:

   a. When the engine is started the air pump compresses and discharges air to the diverter valve

   b. Manifold vacuum opens the diverter valve where the air is metered and sent to the air injection manifolds

   c. A check valve in each air injection manifold allows compressed air to flow into the exhaust port but prevents return of the air and gases to the diverter valve

   d. Injected air is mixed with exhaust gases to continue the combustion process of unburned hydrocarbons

4. a. Provides pressure relief to the system caused by:

      1) Excess pump volume

      2) Restrictions in the hoses and systems tubing

   b. Dumps pump output to the atmosphere under the following conditions:

      1) Engine deceleration

      2) When engine coolant temperature is below normal operating level

      3) When engine coolant temperature is above normal operating level

      4) When the floor pan temperature is above normal operating level

5. a.

6. a. Exhaust gas oxygen sensor
   b. Electronic control module
   c. Variable ratio carburetor
   d. Three-way catalytic converter
   e. Throttle switch
   f. Air supply valve
7. a. Pulse air valve assembly
   b. Check valves (located in valve assembly)
   c. Connecting tubes
8. Explanation should include:
   a. The check valves are connected to separate exhaust ports by pipes
   b. Air is drawn in through the check valves as exhaust manifold pressure changes at each port
   c. The negative pressure or vacuum created at the exhaust port allows fresh air to mix with exhaust gases in the exhaust manifold
   d. Exhaust gases continue the combustion process to reduce hydrocarbon emissions
   e. When positive pressure is present, the check valve closes and burned gases are exhausted through the system as normal
   f. The process is repeated for each cylinder to serve the same purpose as injected air methods
9. Performance skills evaluated to the satisfaction of the instructor

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the purpose of catalytic converter systems. The student should also be able to explain the functions of the catalytic system components and perform maintenance activities. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define the emissions triad.
2. Match the components of the catalytic converter system to their functions.
3. State the purpose of the catalytic converter system.
4. Match the type of catalytic converter systems to their proper descriptions.
5. Describe the four components of a three way catalytic converter (TWC).
6. Explain the function of a two way converter (COC).
7. Explain the function of a three way catalytic converter (TWC).
8. Explain the operation of the catalytic converter protection system during the operating conditions of deceleration, cold air, and warm-up.
9. State the two purposes of nonleaded gasoline.
10. Demonstrate the ability to:
    a. Replace the catalyst in a converter.
    b. Check for proper operation of the catalytic converter protection system.

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide students with information sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined in the job sheets.

(NOTE: It is suggested that the instructor make up job sheets according to the specific make and model of vehicle available to the shop.)

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Exhaust System With Catalytic Converter and Heat Shields
2. TM 2--Two Way (COC) Catalytic Converter Components

3. TM 3--Three Way Catalytic Converter

4. TM 4--Catalyst Protection System (Advanced Type)

5. TM 5--Three Way Converter System

6. TM 6--Unleaded Fuel Filler Inlet

D. Job sheets

1. Job Sheet #1--Replace the Catalyst in a Converter

2. Job Sheet #2--Check for Proper Operation of the Catalytic Converter Protection System

E. Test

F. Answers to test

II. References

A. Chrysler Corporation. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual*. Detroit, Michigan: Service Department, 1978.

B. Ford Motor Company. *1979 Full Size Car Shop Manual*. Detroit, Mich.: Helm, Inc., 1978.

C. Ford Motor Company. *Vehicle Emission Control Systems*. Detroit, Michigan: Service Publications/Helm, Inc., 1978.

D. General Motors Corporation. *Emission Control Systems Maintenance Manual*. Detroit, Michigan: Service Section/ General Motors Corporation, 1978.

E. General Motors Corporation. *1979 Passenger Car Service Manual*. Detroit, Michigan: Service Section/General Motors Corporation, 1979.

F. Glenn, Harold T. "The 1975 Cars--New Concepts for the Auto Shop-School Shop," *Industrial-Technical Education*, Oct. 1974.

G. Henein, N.A. and Patterson, D. J. *Emissions From Combustion Engines and Their Control*, Ann Arbor, Mich.: Ann Arbor Science Publications, Inc.

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

INFORMATION SHEET

I. Emissions triad--The emissions triad are emissions containing oxides of nitrogen, unburned hydrocarbons, and carbon monoxide gases

II. Components and functions of the catalytic converter system

A. Catalyst--Substance used in converters which alters exhaust gas chemistry

B. Rhodium--Catalytic substance which controls oxides of nitrogen (NO_x) emissions

C. Palladium--Catalytic substance which controls hydrocarbon and carbon monoxide emissions

D. Platinum--Catalytic substance which controls hydrocarbon and carbon monoxide emissions

E. Monolithic material--Catalyst coated ceramic material which is honeycombed to provide a larger surface area for exhaust gases to pass through (Transparency 2)

F. Stainless steel mesh--Metal covering the catalyst element used to provide protection and speed up heat transfer within the converter (Transparency 2)

G. Heat shield--Provides protection to car chassis and environment from heat generated by the converter system (Transparency 1)

H. Secondary air--Air injected into exhaust system to continue the burning of hydrocarbons

I. Electronic sensors--Switch-like devices located throughout the engine and chassis which monitor operating conditions of the automobile

J. Electronic control unit (module)--Major component of an electronically controlled system which receives signals from sensors and sends impulses to appropriate engine controls (Transparency 4)

(NOTE: The electronic control unit or the module (ECU or ECM) is the "brain" of the system. The printed circuits and microprocessor components are programmed to perform logic functions. This unit selects proper carburetor and secondary air settings according to input signals from the sensors. Each unit is programmed for the vehicle model and engine application for precise operating conditions.)

INFORMATION SHEET

K. Air supply valve--Controls injected air flow from the air pump to the converter or to the exhaust manifold (Transparency 5)

III. Purpose of the catalytic converter system--The purpose of the catalytic converter system is to reduce the oxides of nitrogen, hydrocarbon, and carbon monoxide emissions from exhaust gases

IV. Types and description of catalytic systems

A. Two-way converter (COC--Conventional Oxidation Catalyst)

1. Contains palladium and/or platinum catalyst

2. Controls only hydrocarbons and carbon monoxide emission

3. Used with or without secondary air injection system

B. Three-way converter (TWC)

1. Contains rhodium, platinum and/or palladium catalyst

2. Controls oxides of nitrogen, hydrocarbons, and carbon monoxide emissions

3. Requires secondary air injection

C. Combination system

1. Uses a manifold or mini-converter(s) and a main converter

2. May use with a COC and a TWC or two COC converters

3. Initiates oxidation process prior to main converter operation

V. Components of a three way catalytic converter (TWC) (Transparency 3)

(NOTE: The TWC consists of two converters in one shell with a mixing chamber separating the two catalyst elements.)

A. Stainless steel shell

B. Front element of rhodium and platinum or palladium coated monolith

C. Mixing chamber with secondary air inlet

D. Rear element of platinum and/or palladium coated monolith

INFORMATION SHEET

VI. Function of a two way converter (COC)(Transparency 2)

A. Exhaust gases enter the converter and flow through the honeycomb element

(NOTE: Some systems use beads instead of a honeycomb element.)

B. Catalyst coating on the element begins to oxidize the hydrocarbon and carbon monoxide emissions

C. The oxidation process produces high temperatures in the converter

D. Higher temperatures produce a better oxidation process

E. Secondary air injected into the exhaust manifold improves the oxidation process

(NOTE: During idle conditions, injected air is dumped to the atmosphere to reduce the oxidation process and, therefore, lower temperatures in the converter.)

F. Exhaust gases are cleaned of hydrocarbon and carbon monoxide emissions in the converter

G. Oxidized gases are exhausted as harmless carbon dioxide gas

VII. Function of three way catalytic converter (TWC)

A. Exhaust gases flow through the front converter element (Transparency 5)

(NOTE: In three way converter systems, exhaust gases contain no injected air at operating conditions.)

B. The catalyst coating on the monolithic element oxidizes the emissions triad

C. The oxidation process produces high temperatures in the converter

D. Higher temperatures improve the oxidation process

E. Partially oxidized gases flow through to the rear element

F. Secondary air is injected into the middle chamber and mixes with the exhaust gases

G. The oxidation process continues in the rear element

H. Hydrocarbons and carbon monoxide gases are further reduced

I. Oxidized gases are exhausted as harmless carbon dioxide and nitrogen gases

INFORMATION SHEET

VIII. Operation of the catalytic converter protection system (Transparency 4)

(NOTE: The converter system creates extremely high temperatures during the oxidation process. When extreme amounts of unburned hydrocarbons exist in the exhaust gases, such as in deceleration, the converter could overheat and be damaged. Cold air could also damage the catalyst material.)

A. During deceleration

1. Manifold vacuum is high
2. Vacuum delay valve closes off vacuum to diverter valve
3. Injected air is vented to atmosphere

(NOTE: Injected air in the exhaust system with a high level of unburned hydrocarbons would cause a high rate of combustion and overheat the converter.)

B. During cold air operation

1. Air cleaner sensor is closed
2. Vacuum to diverter valve is cut off
3. Injected air is vented to atmosphere

(NOTE: The injector system would continue to operate when the engine temperature reaches the operating level because of vacuum signals unless an override system was used. Cold air injected into the heated catalyst would damage it.)

C. During engine warm-up

1. PVS sensor closes
2. Vacuum to diverter valve is cut off
3. Injected air is vented to atmosphere

(NOTE: In TWC systems the injected air is diverted to the exhaust manifold rather than the converter.)

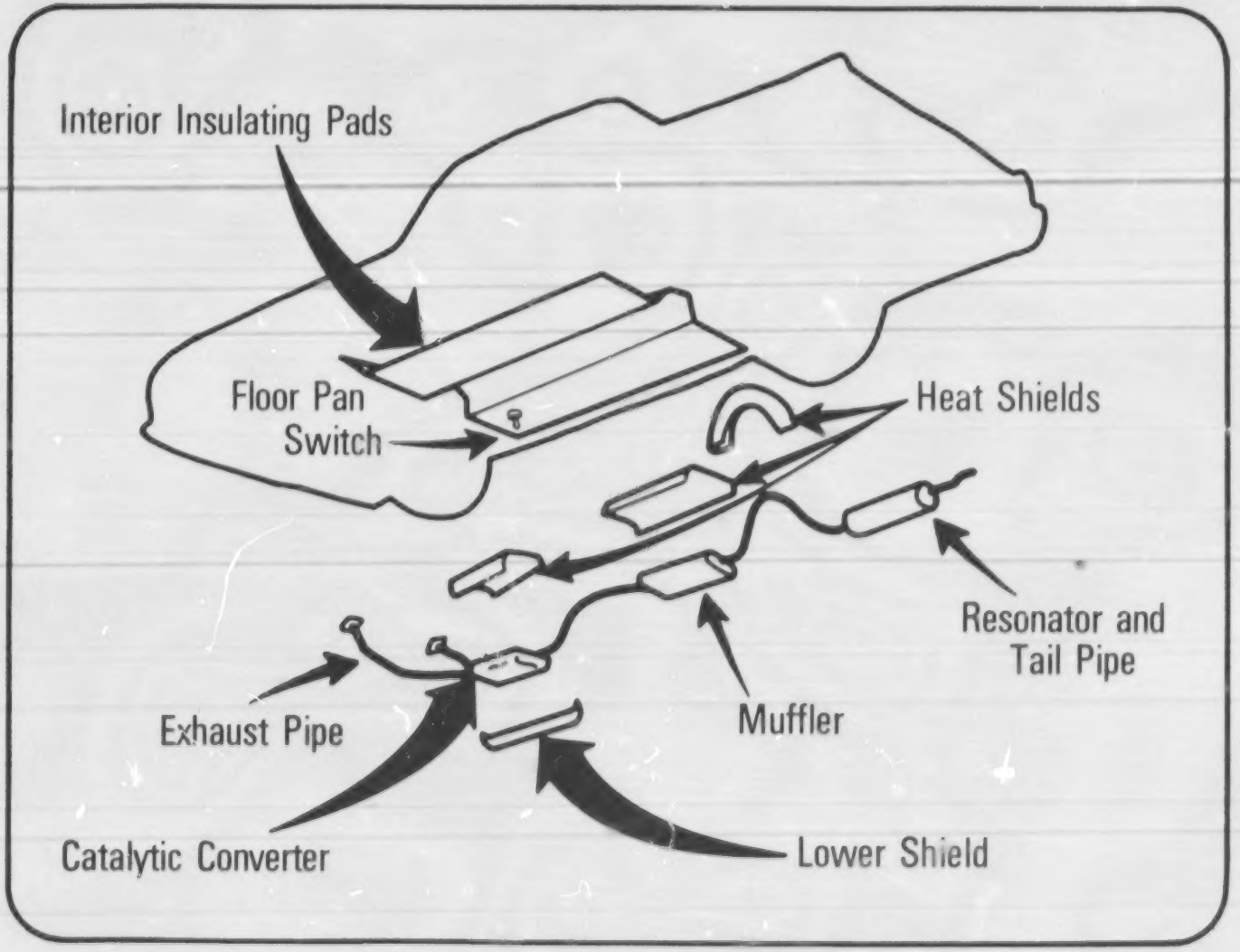
IX. Purposes of nonleaded gasoline (Transparency 6)

A. Prevents coating the catalyst with lead compound

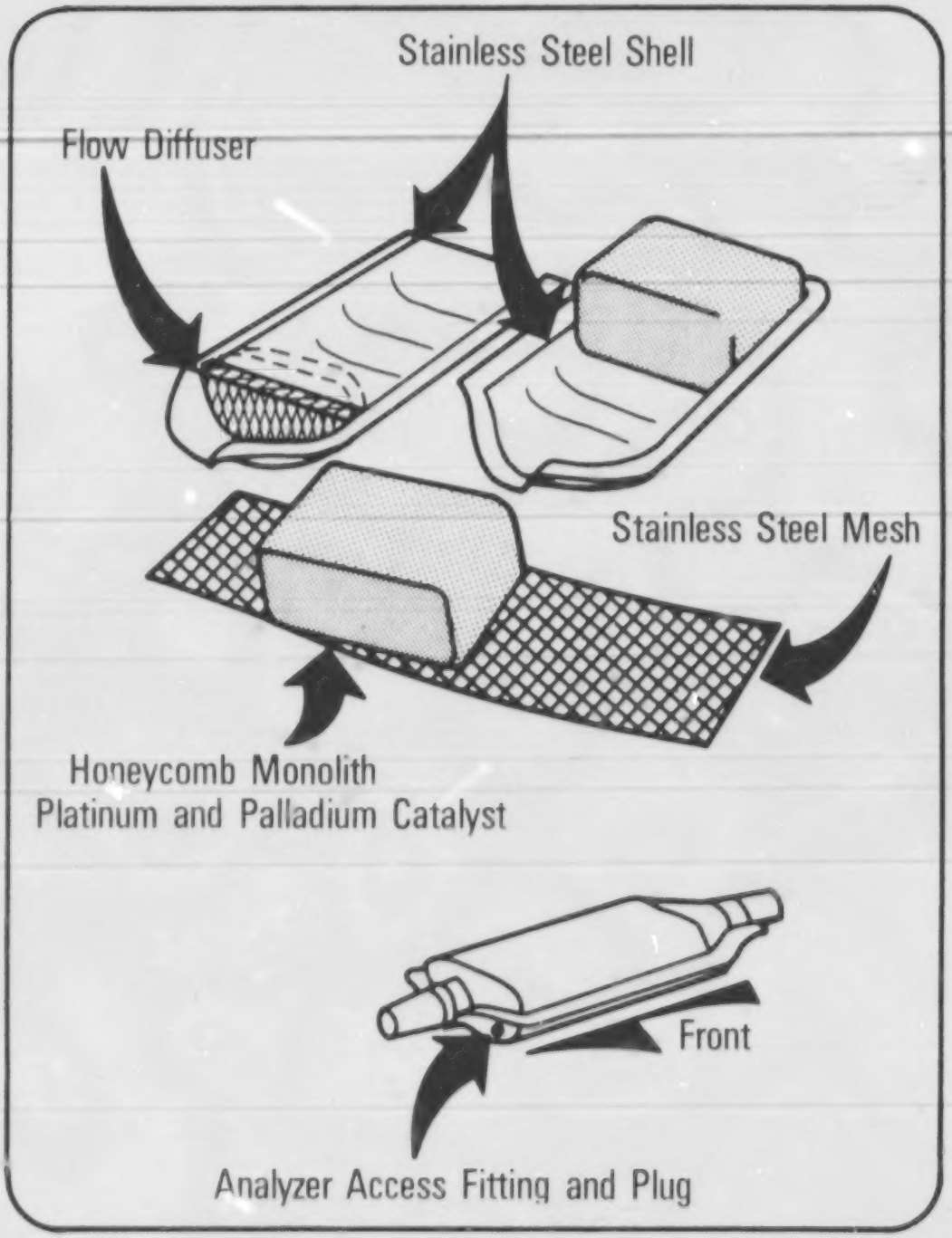
B. Reduces particulate emissions from exhaust

(NOTE: To prevent leaded gasoline usage in automobiles a small filler tube is used and appropriate informative decals are placed near the filler tube opening. It has also been made a federal offense to violate this regulation.)

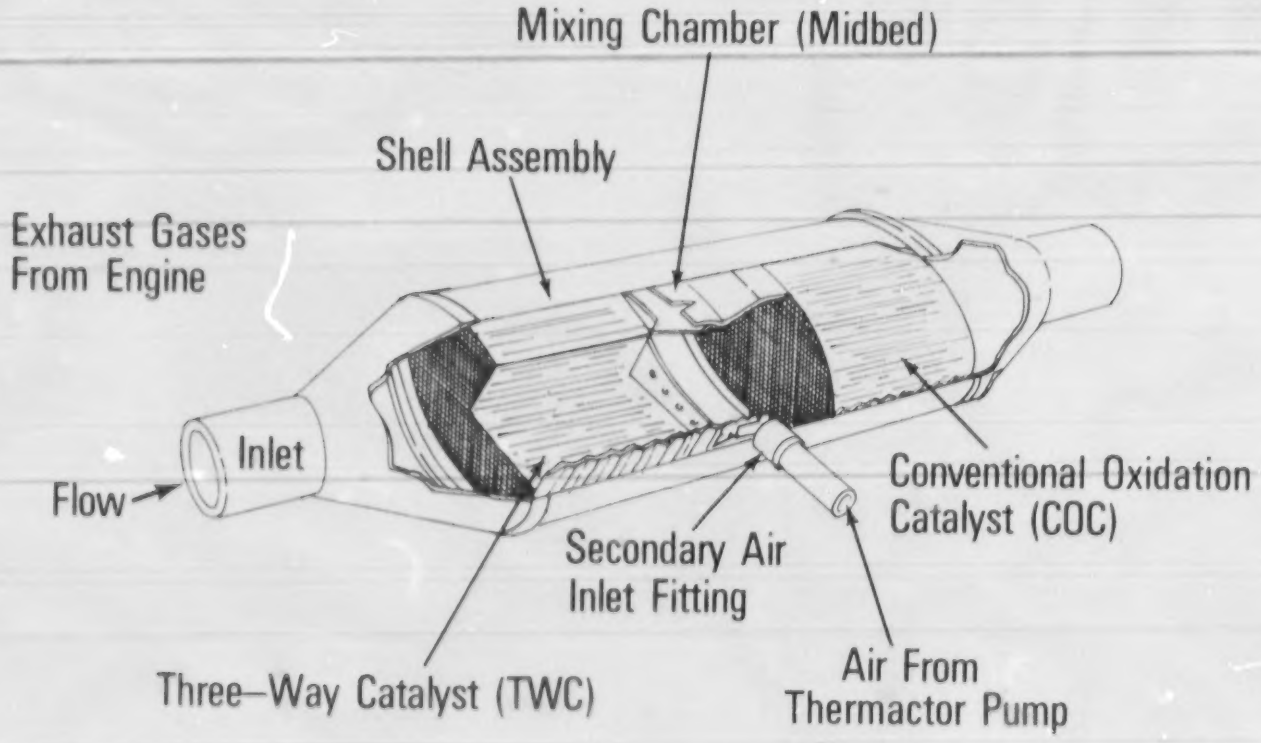
Exhaust System With Catalytic Converter and Heat Shields



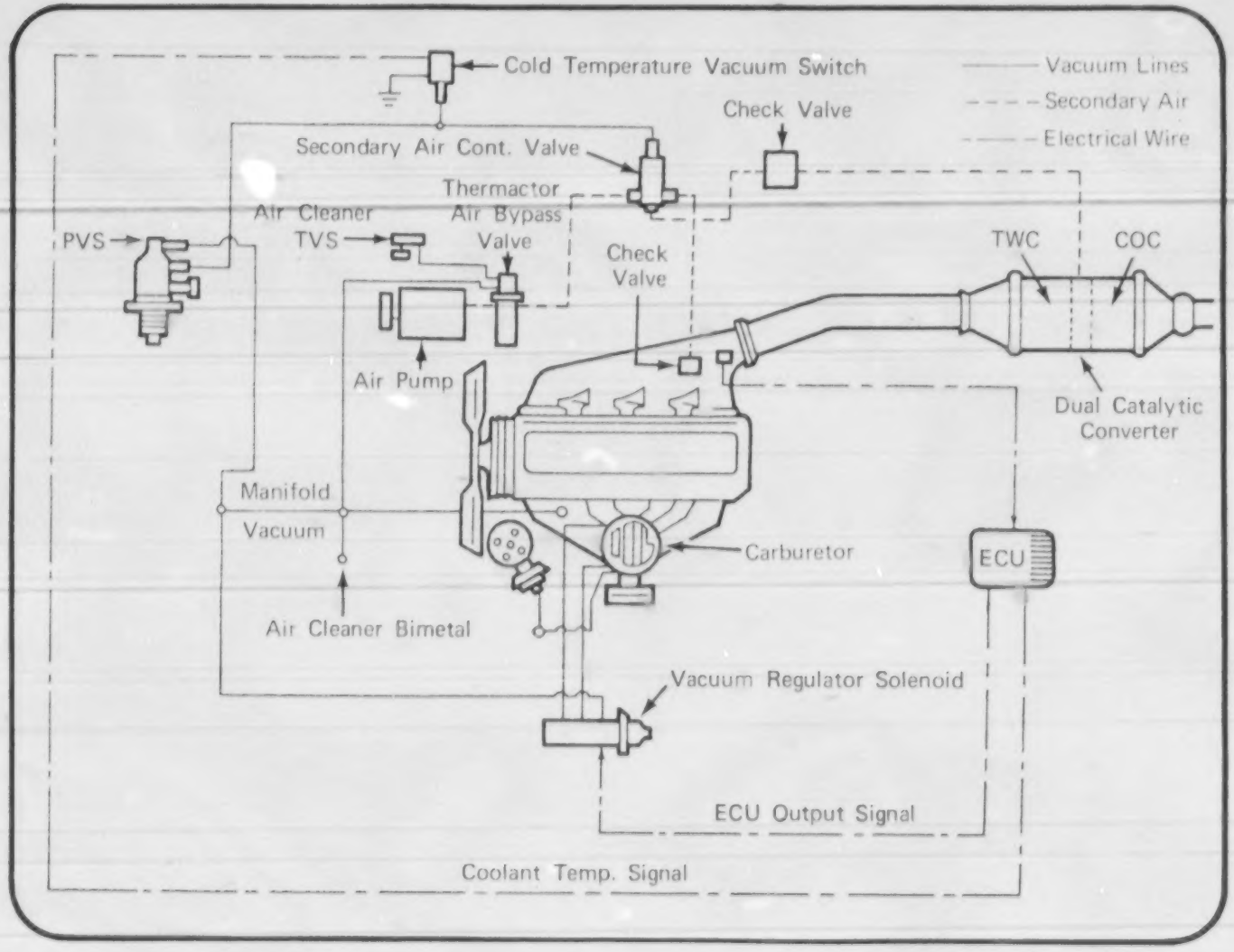
Two Way (COC)
Catalytic Converter Components



Three Way Catalytic Converter

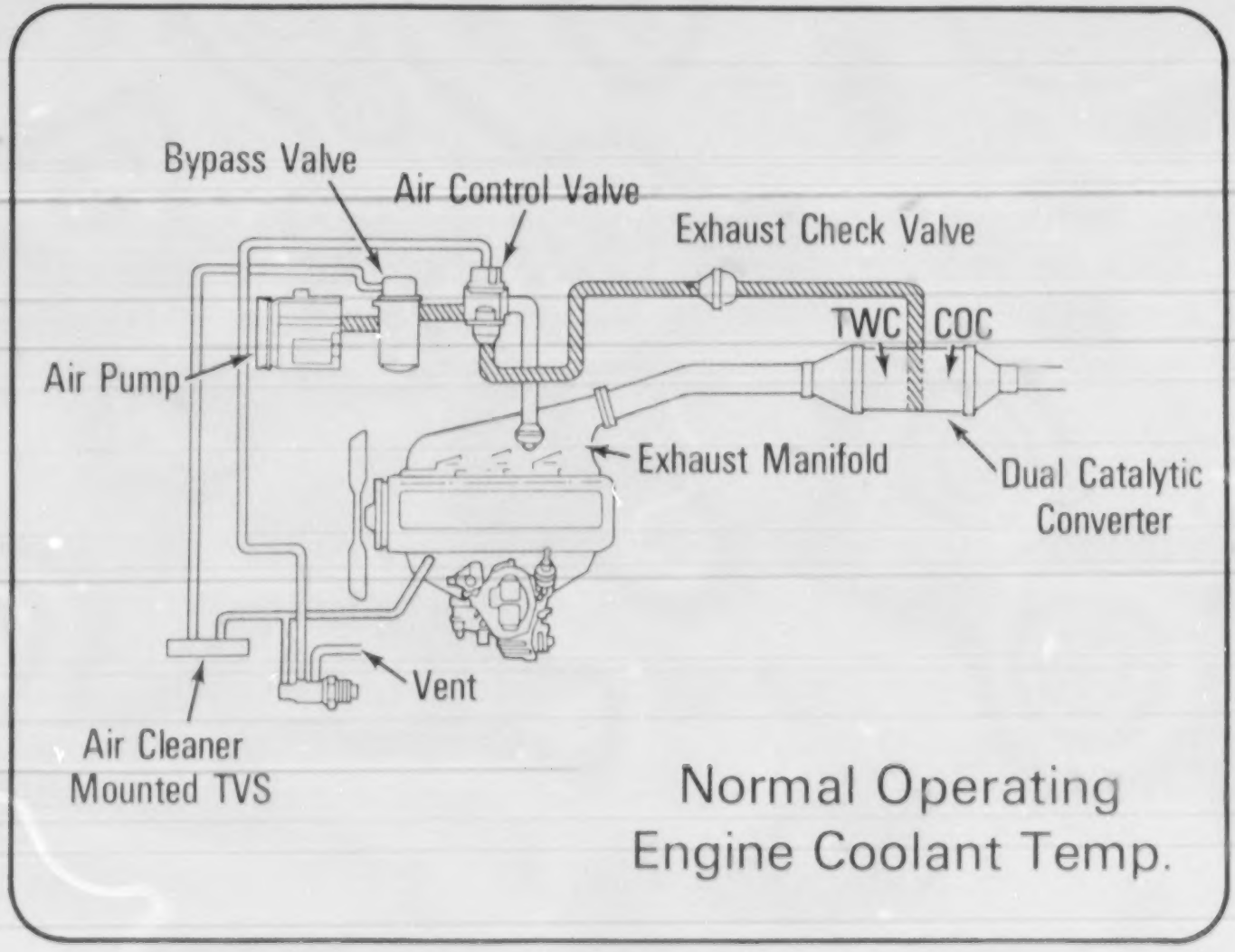


Catalyst Protection System (Advanced Type)

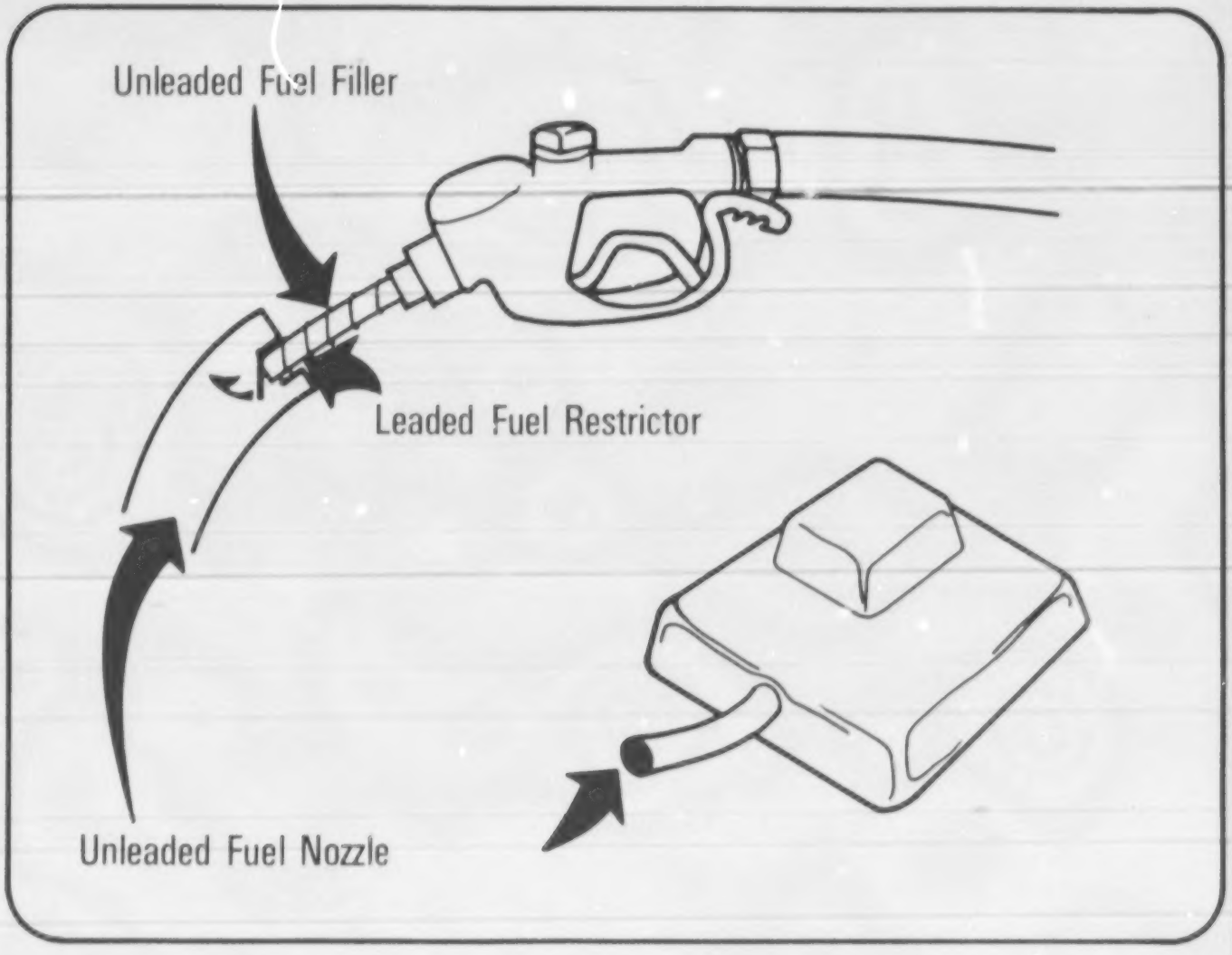


AEC 319

Three Way Converter System



Unleaded Fuel Filler Inlet



CATALYTIC CONVERTER SYSTEMS
UNIT XIV

JOB SHEET #1 REPLACE THE CATALYST IN A CONVERTER

(NOTE: These are replacement procedures for General Motors vehicles only.)

I. Tools and materials

A. General Motors Tool # J-25077 set

B. Shop hand tools

C. Anti-seize compound

D. Replacement catalyst

II. Procedures

A. Raise vehicle on hoist

B. Attach aspirator to tailpipe

C. Connect an air supply hose to aspirator

(NOTE: The air supply creates a vacuum in the converter which holds the catalyst beads in place when the filler is removed.)

D. Remove filler plug

(NOTE: Some models will be fitted with a pressed plug which has to be chiseled out and others have a screw type plug. When chiseling out a plug be careful not to damage the converter housing.)

E. Clamp on vibrator tool and container to converter

F. Remove the air hose from aspirator and connect an air hose to the vibrator

(NOTE: Pellets will fall out of the converter into the container when the vacuum is removed.)

G. When all catalyst pellets are removed, disconnect air hose from vibrator

H. Remove container from vibrator

I. Discard old catalyst and refill container with new pellets

JOB SHEET #1

J. Attach the fill tube to vibrator assembly

K. Connect an air hose to the aspirator and to the vibrator

L. Attach the catalyst container to the vibrator

M. When catalyst beads are in the converter, remove the air hose from the vibrator

N. Remove vibrator from converter and check to see if catalyst beads fill the converter

O. Apply anti-seize compound to filler plug and install it in the converter

P. Disconnect air hose from aspirator and remove all special tools from system

Q. Remove vehicle from hoist

(NOTE: These are general procedures only. Specific procedures can be obtained from General Motors shop manuals.)

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

JOB SHEET #2 CHECK FOR PROPER OPERATION OF THE CATALYTIC CONVERTER PROTECTION SYSTEM

I. Tools and materials

A. Shop hand tools

B. Freon cannister

C. Thermometer

II. Procedure

(NOTE: This procedure applies to vehicles with three way converters.)

A. With automobile under cold start conditions (engine coolant temperature below 52°C, [128°F]), start the engine

B. Remove air supply hose from air supply valve to exhaust manifold

C. Check for air flow to manifold

(NOTE: Air flow can be felt or heard coming from hose. If air is felt, system is operating properly.)

D. Replace hose

E. Allow engine to warm to operating temperature

F. Remove air hose from air supply valve to converter

G. Check for air flow to converter

(NOTE: Air should be felt or heard if system is operating properly.)

H. Replace air hose

I. Stop engine

J. Remove air cleaner cover and spray temperature sensor with freon

(NOTE: This procedure will simulate cold air conditions at inlet. A wet cloth placed on the sensor will accomplish the same effect. A thermometer can be used to determine if temperature at sensor is below 9°C [49°F].)

JOB SHEET #2

K. Start the engine

L. Check for air flow from diverter valve muffler

(NOTE: If the system is operating properly, the air pump supply will be dumped into the atmosphere rather than being sent to the air supply valve.)

M. Stop engine and replace air cleaner cover

(NOTE: If the system does not function properly, check the operation of the PVS valve and related components. These steps are basic procedures. Exact procedures and settings can be obtained from manufacturer's shop manuals.)

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

NAME _____

TEST

1. Define the emissions triad.

2. Match the components of the catalytic converter system on the right to their functions.

_____a. Substance used in converters which alters exhaust gas chemistry	1. Stainless steel mesh
_____b. Catalytic substance which controls oxides of nitrogen (NO_x) emissions	2. Palladium
_____c. Catalytic substance which controls hydrocarbon and carbon monoxide emissions	3. Electronic sensors
_____d. Catalytic substance which controls hydrocarbon and carbon monoxide emissions	4. Catalyst
_____e. Catalyst coated ceramic material which is honeycombed to provide a larger surface area for exhaust gases to pass through	5. Secondary air
_____f. Metal covering the catalyst element used to provide protection and speed up heat transfer within the converter	6. Platinum
_____g. Provides protection to car chassis and environment from heat generated by the converter system	7. Monolithic material
_____h. Air injected into exhaust system to continue the burning of hydrocarbons	8. Air supply valve
_____i. Switch-like devices located throughout the engine and chassis which monitor operating conditions of the automobile	9. Rhodium
_____j. Major component of an electronically controlled system which receives signals from sensors and sends impulses to appropriate engine controls	10. Electronic control unit (module)
_____k. Controls injected air flow from the air pump to the converter or to the exhaust manifold	11. Heat shield

3. State the purpose of the catalytic converter system.

4. Match the types of catalytic converter systems on the right to their descriptions.

_____a.	1)	Contains rhodium, platinum and/or palladium catalyst	1. Combination system
	2)	Controls oxides of nitrogen, hydrocarbons, and carbon monoxide emissions	2. Two-way converter (COC - Conventional Oxidation Catalyst)
	3)	Requires secondary air injection	
_____b.	1)	Uses a manifold or mini-converter(s) and a main converter	3. Three-way converter (TWC)
	2)	May use either a COC and a TWC or two COC converters	
	3)	Initiates oxidation process prior to main converter operation	
_____c.	1)	Contains palladium and/or platinum catalyst	
	2)	Controls only hydrocarbons and carbon monoxide emissions	
	3)	Used with or without secondary air injection system	

5. Describe the four components of a three way catalytic converter.

a.

b.

c.

d

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

NAME _____

TEST

1. Define the emissions triad.

2. Match the components of the catalytic converter system on the right to their functions.

_____a. Substance used in converters which alters exhaust gas chemistry

_____b. Catalytic substance which controls oxides of nitrogen (NO_x) emissions

_____c. Catalytic substance which controls hydrocarbon and carbon monoxide emissions

_____d. Catalytic substance which controls hydrocarbon and carbon monoxide emissions

_____e. Catalyst coated ceramic material which is honeycombed to provide a larger surface area for exhaust gases to pass through

_____f. Metal covering the catalyst element used to provide protection and speed up heat transfer within the converter

_____g. Provides protection to car chassis and environment from heat generated by the converter system

_____h. Air injected into exhaust system to continue the burning of hydrocarbons

_____i. Switch-like devices located throughout the engine and chassis which monitor operating conditions of the automobile

_____j. Major component of an electronically controlled system which receives signals from sensors and sends impulses to appropriate engine controls

_____k. Controls injected air flow from the air pump to the converter or to the exhaust manifold

1. Stainless steel mesh
2. Palladium
3. Electronic sensors
4. Catalyst
5. Secondary air
6. Platinum
7. Monolithic material
8. Air supply valve
9. Rhodium
10. Electronic control unit (module)
11. Heat shield

3. State the purpose of the catalytic converter system.

4. Match the types of catalytic converter systems on the right to their descriptions.

_____a.	1)	Contains rhodium, platinum and/or palladium catalyst	1. Combination system
	2)	Controls oxides of nitrogen, hydrocarbons, and carbon monoxide emissions	2. Two-way converter (COC Conventional Oxidation Catalyst)
	3)	Requires secondary air injection	
_____b.	1)	Uses a manifold or mini-converter(s) and a main converter	3. Three-way converter (TWC)
	2)	May use either a COC and a TWC or two COC converters	
	3)	Initiates oxidation process prior to main converter operation	
_____c.	1)	Contains palladium and/or platinum catalyst	
	2)	Controls only hydrocarbons and carbon monoxide emissions	
	3)	Used with or without secondary air injection system	

5. Describe the four components of a three way catalytic converter.

a.

b.

c.

d.

6. Explain the function of a two way converter (COC).

7. Explain the function of a three way catalytic converter (TWC).

8. Explain the operation of the catalytic converter protection system during the operating conditions of deceleration, cold air, and warm up.

9. State two purposes of nonleaded gasoline.

   a.

   b.

10. Demonstrate the ability to:

    a. Replace the catalyst in a converter.

    b. Check for proper operation of the catalytic converter protection system.

    (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

CATALYTIC CONVERTER SYSTEMS
UNIT XIV

ANSWERS TO TEST

1. The emissions triad are emissions containing oxides of nitrogen, unburned hydrocarbons, and carbon monoxide gases

2. a. 4 e. 7 i. 3
   b. 9 f. 1 j. 10
   c. 2 g. 11 k. 8
   d. 6 h. 5

3. The purpose of the catalytic converter system is to reduce the oxides of nitrogen, hydrocarbon, and carbon monoxide emissions from exhaust gases

4. a. 3
   b. 1
   c. 2

5. Description should include:
   a. Stainless steel shell
   b. Front element of rhodium and platinum or palladium coated monolith
   c. Mixing chamber with secondary air inlet
   d. Rear element of platinum and/or palladium coated monolith

6. Explanation should include:
   a. Exhaust gases enter the converter and flow through the honeycomb element
   b. Catalyst coating on the element begins to oxidize the hydrocarbon and carbon monoxide emissions
   c. The oxidation process produces high temperatures in the converter
   d. Higher temperatures produce a better oxidation process
   e. Secondary air injected into the exhaust manifold improves the oxidation process
   f. Exhaust gases are cleaned of hydrocarbon and carbon monoxide emissions in the converter
   g. Oxidized gases are exhausted as harmless carbon dioxide gas

7. Explanation should include:
   a. Exhaust gases flow through the front converter element
   b. The catalyst coating on the monolithic element oxidizes the emissions triad
   c. The oxidation process produces high temperatures in the converter
   d. Higher temperatures improve the oxidation process
   e. Partially oxidized gases flow through to the rear element
   f. Secondary air is injected into the middle chamber and mixes with the exhaust gases
   g. The oxidation process continues in the rear element
   h. Hydrocarbons and carbon monoxide gases are further reduced
   i. Oxidized gases are exhausted as harmless carbon dioxide and nitrogen gases
8. Explanation should include:
   a. During deceleration
      1) Manifold vacuum is high
      2) Vacuum delay valve closes off vacuum to diverter valve
      3) Injected air is vented to atmosphere
   b. During cold air operation
      1) Air cleaner sensor is closed
      2) Vacuum to diverter valve is cut off
      3) Injected air is vented to atmosphere
   c. During engine warm up
      1) PVS sensor closes
      2) Vacuum to diverter valve is cut off
      3) Injected air is vented to atmosphere
9. a. Prevents coating the catalyst with lead compound
   b. Reduces particulate emissions from exhaust
10. Performance skills evaluated to the satisfaction of the instructor

ELECTRONIC CONTROLS
UNIT XV

UNIT OBJECTIVE

After completion of this unit, the student should be able to explain the operation of electronic devices currently used in the automotive industry. This knowledge will be evidenced by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match components of an electronically controlled engine system to their proper functions.
2. Identify the components of an electronically controlled engine system.
3. List the processes performed by the two units in the electronic control module.
4. Explain the basic operation of an electronically controlled engine system.

ELECTRONIC CONTROLS
UNIT XV

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide student with objective sheet.

B. Provide student with information sheet.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheet.

F. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Electronic Control System
2. TM 2--Electronic Components
3. TM 3--General Motors C-4 System
4. TM 4--Ford Motor Company System

G. Test

H. Answers to test

II. References:

A. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

B. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1979.

C. Ford Motor Company. *Vehicle Emission Control Systems.* Detroit, Michigan: Service Publications/Helm, Inc., 1978.

D. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Service Department/Chrysler Corporation, 1978.

E. *Buick Chassis Service Manual.* Flint, Michigan: Buick Motor Division/General Motors Corporation, 1979.

ELECTRONIC CONTROLS
UNIT XV

INFORMATION SHEET

I. Components and functions (Transparencies 1, 2, 3, and 4)

A. Ambient air temperature sensor--Monitors air temperature to provide information needed to calculate fuel, ignition, and combustion settings

B. Barometric pressure sensor--Monitors relative pressure of the atmosphere to provide a comparison figure for manifold pressure calculations

C. Coolant temperature sensor--Monitors engine temperature to provide information needed to calculate cold start and overheat settings

D. Manifold pressure sensor--Monitors air pressures of the EGR and air injection systems to provide information needed for ignition, fuel, and combustion adjustment

E. Oxygen sensor--Monitors oxygen levels in the exhaust gases to provide information needed for carburetor adjustment and ignition setting

F. Electronic control module--The central control component which contains a microcomputer used to analyze all input signals from the sensors and calculates and sends precise signals to control solenoids on engine controls

G. High energy ignition--A solid state electronic ignition system which provides an extremely high voltage on the secondary side for more efficient spark

H. Throttle position sensor--Monitors the position of throttle plate to provide fuel and ignition setting information

I. Crankshaft sensor--Monitors position of pistons according to crankshaft position which provides information for the ignition timing calculations

J. Breakerless distributor--An armature and stator assembly which replace the breaker plate or points as a more efficient method of handling the higher voltage of the electronic ignition system

K. EGR valve sensor--Monitors the air flow in, or the position of EGR valve to provide signals relative to the pressures and operation of the air injection and EGR systems

L. Transducer--A monitoring sensor which sends out signals of different strengths depending on its position between open and closed

(NOTE: As with any sensor, the transducer position is calculated by the control unit according to the strength of the impulse sent out by the transducer.)

INFORMATION SHEET

II. Components of an electronically controlled engine system (Transparencies 1, 2, 3, and 4)

A. Ambient air temperature sensor

B. Coolant temperature sensor

C. Electronic control unit

D. High energy ignition

E. Barometric pressure sensor

F. Oxygen sensor or manifold pressure sensor

G. Crankshaft sensor

H. Throttle position sensor

I. EGR valve sensor

(NOTE: The systems used by various manufacturers differ slightly but the components are basically the same. The control module of each system has a calibration component that is specifically designed to match engine application and accessories. Each engine requires different air fuel mixtures according to engine load. The computer selects the appropriate settings for the most efficient emission control as determined by the calibration assembly installed.)

III. Processes performed by the processor unit and calibration unit of the electronic control module

(NOTE: The control unit is the brain of the system. It is a solid state, microcomputer device which has two main parts: a processor unit and a calibration unit that is interchangeable to engine application.)

A. Processes performed by the processor unit

1. Analyzes sensor input signals continuously

2. Converts the signals to computer usable codes

3. Calculates ignition timing

4. Calculates carburetor settings

5. Provides constant voltage to sensors

6. Sends electrical signals to ignition, carburetor, and other engine control solenoids (EGR, air injection, etc.)

INFORMATION SHEET

B. Processes performed by the calibration unit

1. Converts sensor input in relation to specifications of engine application

2. Provides calibrated signals to processor component

IV. Operation of an electronically controlled engine system

A. The system sensors monitor engine conditions continuously

B. Signals are sent to the electronic control unit

C. The calibration component adjusts the signals to preprogrammed specifications

D. The processor component analyzes the signals and performs calculations

E. Electrical signals are sent to appropriate control solenoids to:

1. Adjust timing

2. Adjust carburetor settings

3. Regulate air injection and EGR flows

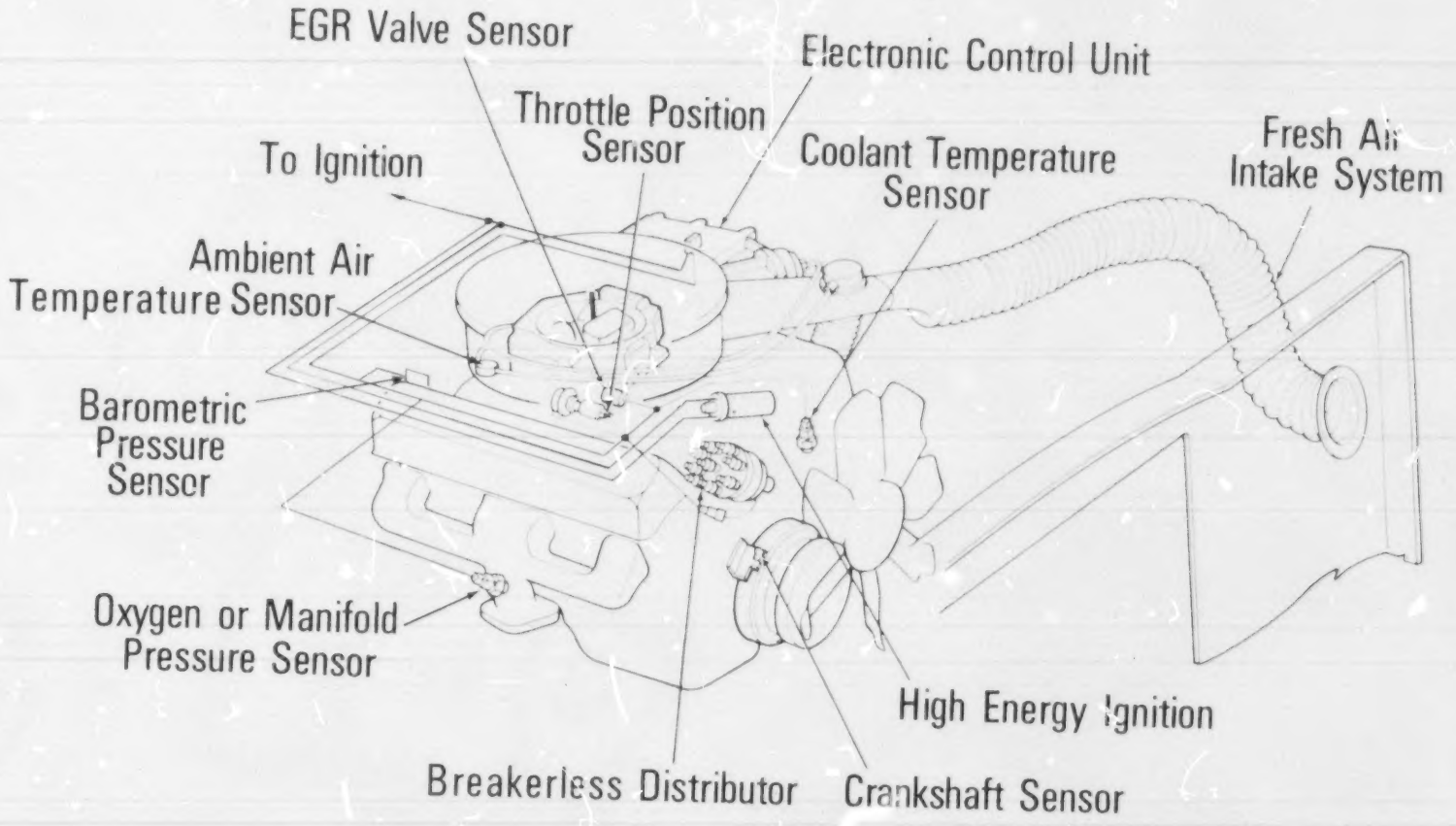
(NOTE: The system is electrical but may involve some vacuum assist to open and close valves or operate motor assemblies.)

F. Emissions are regulated precisely for most efficient operation of the automobile

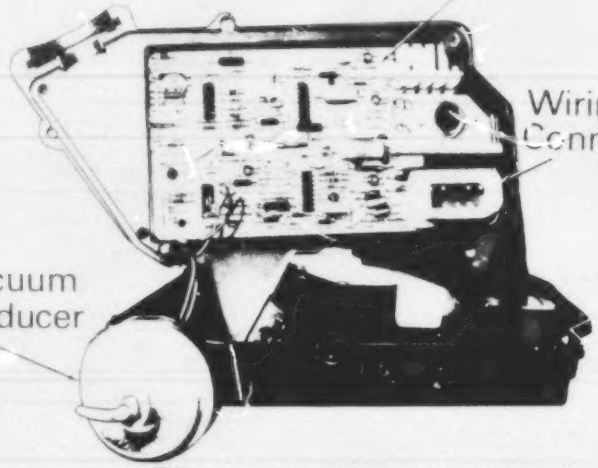
G. If any malfunction occurs, the system automatically adjusts spark advance to approximately 10 degrees to permit vehicle operation

(NOTE: Some systems perform carburetor and ignition adjustments while others perform only ignition or carburetor adjustments.)

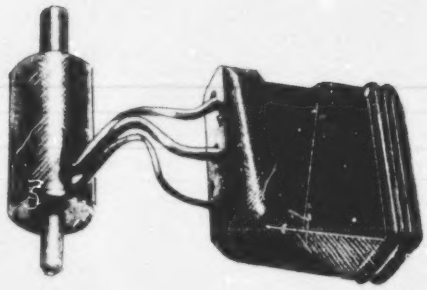
Electronic Control System



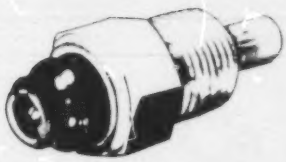
Electronic Components



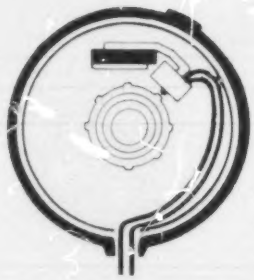
Electronic Control Unit



Throttle Position Sensor



Coolant Temperature Sensor

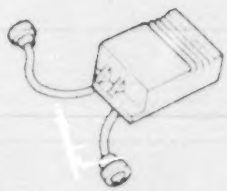


Breakerless Distributor

Oxygen Sensor

Crankshaft Position Sensor

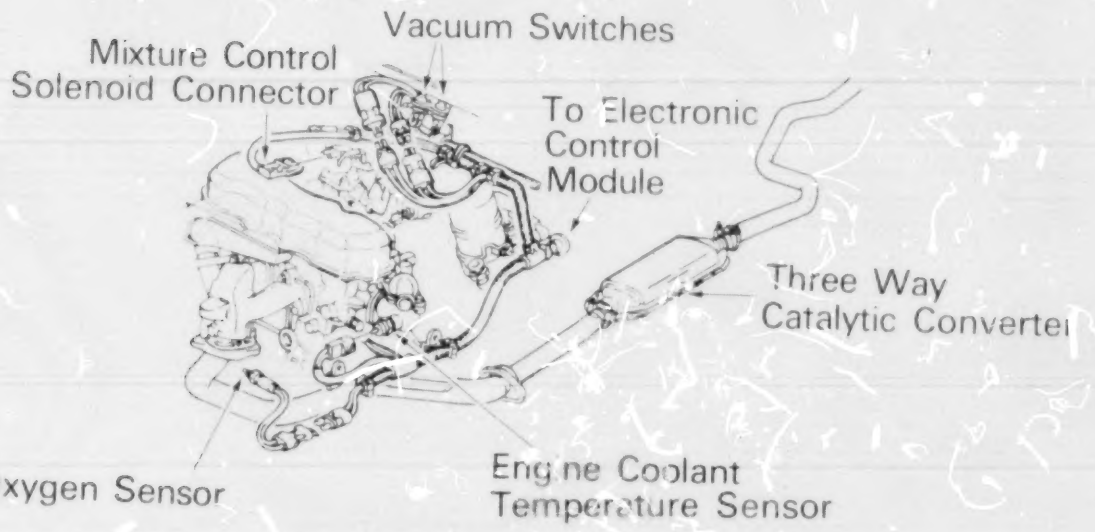
EGR Valve Actuator and Position Sensor



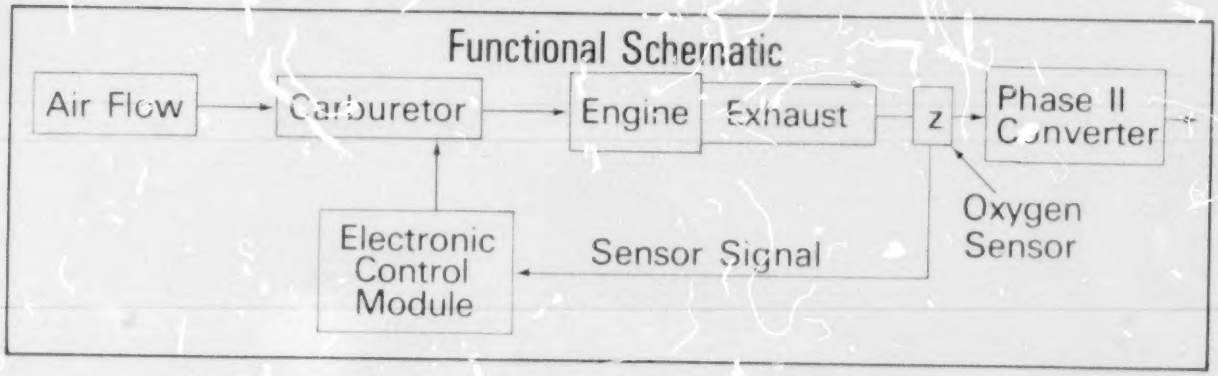
High Energy Ignition Module

General Motors C-4 System

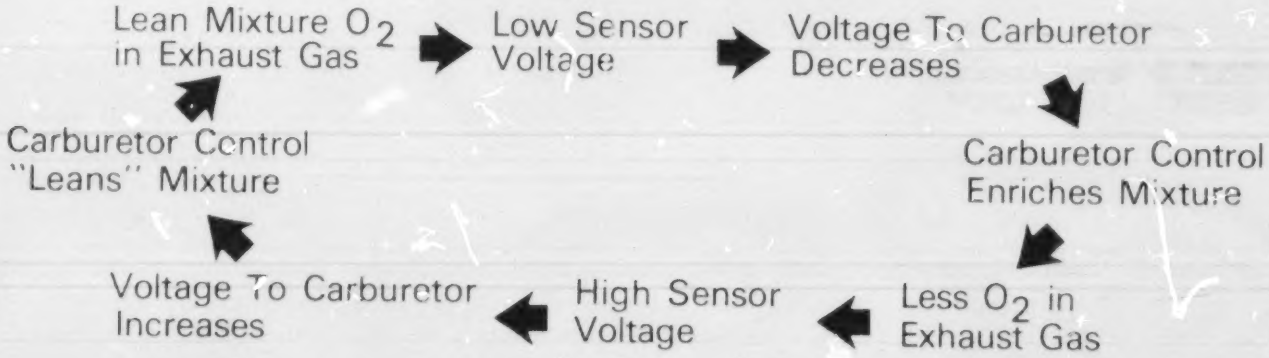
Sensor and Control Locations



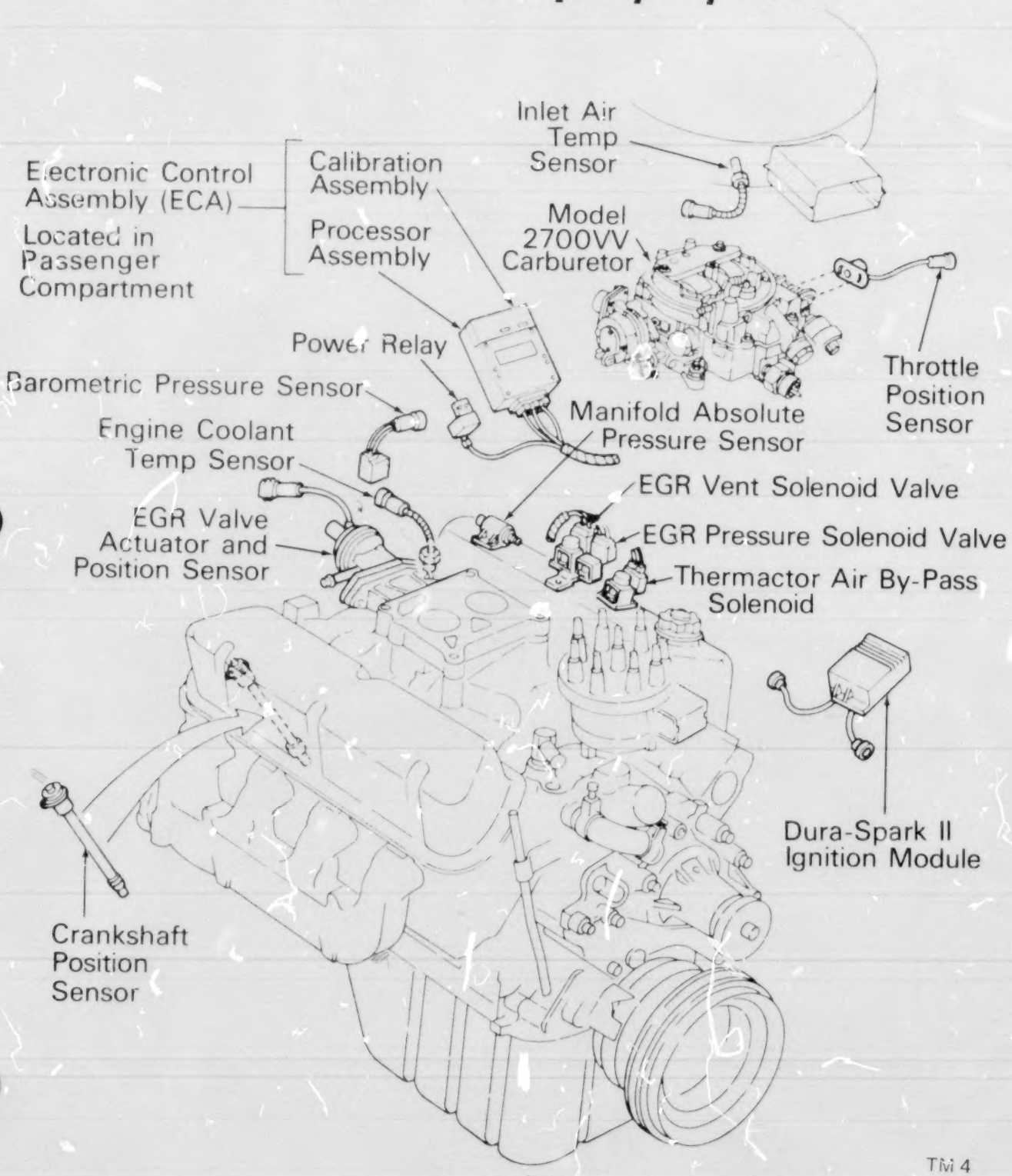
Functional Schematic



Electronic Fuel Control Cycle of Operation


Lean Mixture O_2 in Exhaust Gas
Low Sensor Voltage
Voltage To Carburetor Decreases
Carburetor Control Enriches Mixture
Less O_2 in Exhaust Gas
High Sensor Voltage
Voltage To Carburetor Increases
Carburetor Control "Leans" Mixture

Ford Motor Company System



TM 4

ELECTRONIC CONTROLS
UNIT XV

NAME _____

TEST

1. Match the components of an electronic controlled engine on the right to their proper functions.

_____a. Monitors oxygen levels in the exhaust gases to provide information for carburetor adjustment and ignition setting

_____b. Monitors engine temperature to provide information needed to calculate cold start and overheat settings

_____c. A monitoring sensor which sends out signals of different strengths depending on its position between open and closed

_____d. A solid state electronic ignition system which provides an extremely high voltage on the secondary side for more efficient spark

_____e. Monitors position of pistons according to crankshaft position which provides information for the ignition timing calculations

_____f. Monitors air pressures of the EGR and air injection systems to provide information needed for ignition, fuel, and combustion adjustments

_____g. Monitors air temperature to provide information needed to calculate fuel, ignition, and combustion settings

_____h. Monitors the position of the throttle plate to provide fuel and ignition setting information

_____i. An armature and stator assembly which replace the breaker plate or points as a more efficient method of handling the higher voltage of the electronic ignition system

_____j. Monitors relative pressure of the atmosphere to provide a comparison figure for manifold pressure calculations

1. Oxygen sensor
2. Barometric pressure sensor
3. Ambient air temperature sensor
4. Electronic control module
5. Coolant temperature sensor
6. Manifold pressure sensor
7. High energy ignition
8. Throttle position sensor
9. Crankshaft sensor
10. Breakerless distributor
11. EGR valve sensor
12. Transducer

_____ k. The central control component which contains a microcomputer used to analyze all input signals from the sensors and calculates and sends precise signals to control solenoids on engine controls

_____ l. Monitors the air flow in, or the position of the EGR valve to provide signals relative to the pressures and operation of the air injection and EGR systems

2. Identify the components of the electronically controlled engine by labeling the appropriate components on the figure below.

a. _____

b. _____

c. _____

d. _____

e. _____

f. _____

g. _____

h. _____

i. _____

3. List the processes performed by the two units in the electronic control module.

   a. The processor unit

      1)

      2)

      3)

      4)

      5)

      6)

   b. The calibration unit

      1)

      2)

4. Explain the operation of an electronically controlled engine system.

ELECTRONIC CONTROLS
UNIT XV

ANSWERS TO TEST

1. a. 1
   b. 5
   c. 12
   d. 7
   e. 9
   f. 6
   g. 3
   h. 8
   i. 10
   j. 2
   k. 4
   l. 11

2. a. EGR valve sensor
   b. Throttle position sensor
   c. Electronic control unit
   d. Coolant temperature sensor
   e. Ambient air temperature sensor
   f. Barometric pressure sensor
   g. Oxygen sensor or manifold pressure sensor
   h. Crankshaft sensor
   i. High energy ignition

3. a. The processor unit
      1) Analyzes sensor input signals continuously
      2) Converts the signals to computer usable codes
      3) Calculates ignition timing
      4) Calculates carburetor settings
      5) Provides constant voltage to sensors
      6) Sends electrical signals to ignition, carburetor, and other engine control solenoids (EGR, air injection, etc.)

b. The calibration unit

1) Converts sensor input in relation to specifications of engine application

2) Provides calibrated signals to processor component

4. Explanation should include:

a. The system sensors monitor engine conditions continuously

b. Signals are sent to the electronic control unit

c. The calibration component adjusts the signals to preprogrammed specifications

d. The processor components analyzes the signals and performs calculations

e. Electrical signals are sent to appropriate control solenoids to:

1) Adjust timing

2) Adjust carburetor settings

3) Regulate air injection and EGR flows

f. Emissions are regulated precisely for most efficient operation of the automobile

g. If any malfunction occurs, the system automatically adjusts spark advance to approximately 10 degrees to permit vehicle operation

TESTING
UNIT XVI

UNIT OBJECTIVE

After completion of this unit, the student should be able to describe the procedures for testing an auto emissions system and perform selected tests to determine proper operation of the system. This knowledge will be evidenced through demonstration and by scoring 85 percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. State the purpose for testing auto emission control systems.
2. Match emission control devices to the pollutants which they control.
3. State the general rules for testing which apply to all spark advance control devices.
4. Select items included on a basic checklist for testing the normal operation of emission control systems.
5. List four steps which are included in the dual diaphragm vacuum advance unit test.
6. State the purpose for using the idle enrichment method of testing emission control systems.
7. Demonstrate the ability to:
   a. Perform a basic check of emission control devices by using a checklist.
   b. Test a dual diaphragm vacuum advance unit for proper operation.
   c. Adjust the idle of an engine using the artificial idle enrichment method.

TESTING
UNIT XVI

SUGGESTED ACTIVITIES

I. Instructor:

A. Provide students with objective sheet.

B. Provide student with information and job sheets.

C. Make transparencies.

D. Discuss unit and specific objectives.

E. Discuss information sheets.

F. Demonstrate and discuss the procedures outlined in the job sheets.

G. Give test.

II. Student:

A. Read objective sheet.

B. Study information sheet.

C. Complete job sheets.

D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

A. Objective sheet

B. Information sheet

C. Transparency masters

1. TM 1--Typical Emission Control Components
2. TM 2--Emission Control System Checklist
3. TM 3--Dual Diaphragm Unit Operation Tests
4. TM 4--Artificial Enrichment

F. Job sheets

1. Job Sheet #1–Perform a Basic Check of Auto Emission Control Devices

2. Job Sheet #2–Test Dual Diaphragm Vacuum Advance Units for Proper Operation

3. Job Sheet #3–Adjust Engine Idle Using the Artificial Idle Enrichment Method

G. Test

H. Answers to test

II. References:

A. Ford Motor Company. *1978 Full Size Car Shop Manual.* Detroit, Mich.: Helm, Inc., 1978.

B. General Motors Corporation. *1979 Passenger Car Service Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1979.

C. Ford Motor Company. *Vehicle Emission Control Systems.* Detroit, Michigan: Service Publications/Helm, Inc., 1978.

D. General Motors Corporation. *Emission Control Systems Maintenance Manual.* Detroit, Michigan: Service Section/General Motors Corporation, 1978.

E. Chrysler Corporation. *1979 Chrysler-Plymouth-Dodge Chassis-Body Service Manual.* Detroit, Michigan: Service Department, 1978.

TESTING
UNIT XVI

INFORMATION SHEET

I. The purpose of testing the auto emission control system--The purpose of testing the auto emission control system is to establish the most efficient operational setting for maximum engine performance and lowest exhaust gas emission level

II. Emission control devices and pollutants (Transparency 1)

(NOTE: Emission control devices are designed to control the three major pollutants: hydrocarbons [HC], carbon monoxide [CO], and nitrous oxides [NO_x].)

	System Component or Device	Pollutants
A.	Heated air induction	HC
B.	Positive crankcase ventilation (PCV)	HC
C.	Carburetor calibration	HC, CO
D.	Distributor design and calibration	HC, CO
E.	Initial engine timing	HC, CO, NO_x
F.	Air injection or pulse air	HC, CO
G.	Spark advance controls	HC, NO_x
H.	Exhaust gas recirculation (EGR)	NO_x
I.	Electric choke assist	HC, CO
J.	Evaporation control system (gas cap, purge cannister)	HC
K.	Catalytic converter (conventional)	HC, CO
L.	Catalytic converter (3 way)	HC, CO, NO_x

III. General rules for testing components of spark advance control systems

(NOTE: These basic rules apply to testing spark advance control systems such as transmission or speed control systems.)

A. If any system does not provide vacuum advance when the engine is either cold or overheated, a temperature control unit is malfunctioning

(NOTE: A temperature control unit may be an ambient air temperature switch, a PVS/TVS switch or similar device.)

B. If any system provides vacuum advance either at idle or when the transmission is in the lower gears, or does not provide vacuum advance when the vehicle transmission is in high gear, a speed control device, solenoid, or control module is malfuntioning

(NOTE: The important point to remember about controlled spark advance is that vacuum spark advance is applied only during normal operating conditions when the transmission is in high gear or the vehicle is at cruising speed and the engine coolant is at normal operating temperature.)

IV. Basic checklist for testing normal operation of emission control systems (Transparency 2)

(NOTE: The basic check generally includes a visual inspection and mirror equipment use.)

A. Check drive belt condition and tension

B. Check air pump filter

C. Check condition and fit of hoses

D. Check condition of fittings to air manifold

E. Check condition of fittings to exhaust manifold

F. Check operation of diverter and check valves

G. Check PCV valve

H. Check ignition timing

I. Set engine idle speed

J. Check condition of catalytic converter

V. Dual diaphragm vacuum advance unit test (Transparency 3)

(NOTE: The following steps are generally followed to determine proper operation of a dual diaphragm vacuum advance unit although manufacturers usually require specific RPM settings and allow only a specific RPM drop between settings.)

A. Step 1 -- Set initial timing to manufacturer's specifications after removing and plugging both vacuum hoses to the advance and retard connections

B. Step 2 -- Test centrifugal advance by accelerating the engine and noting advance on timing marks

INFORMATION SHEET

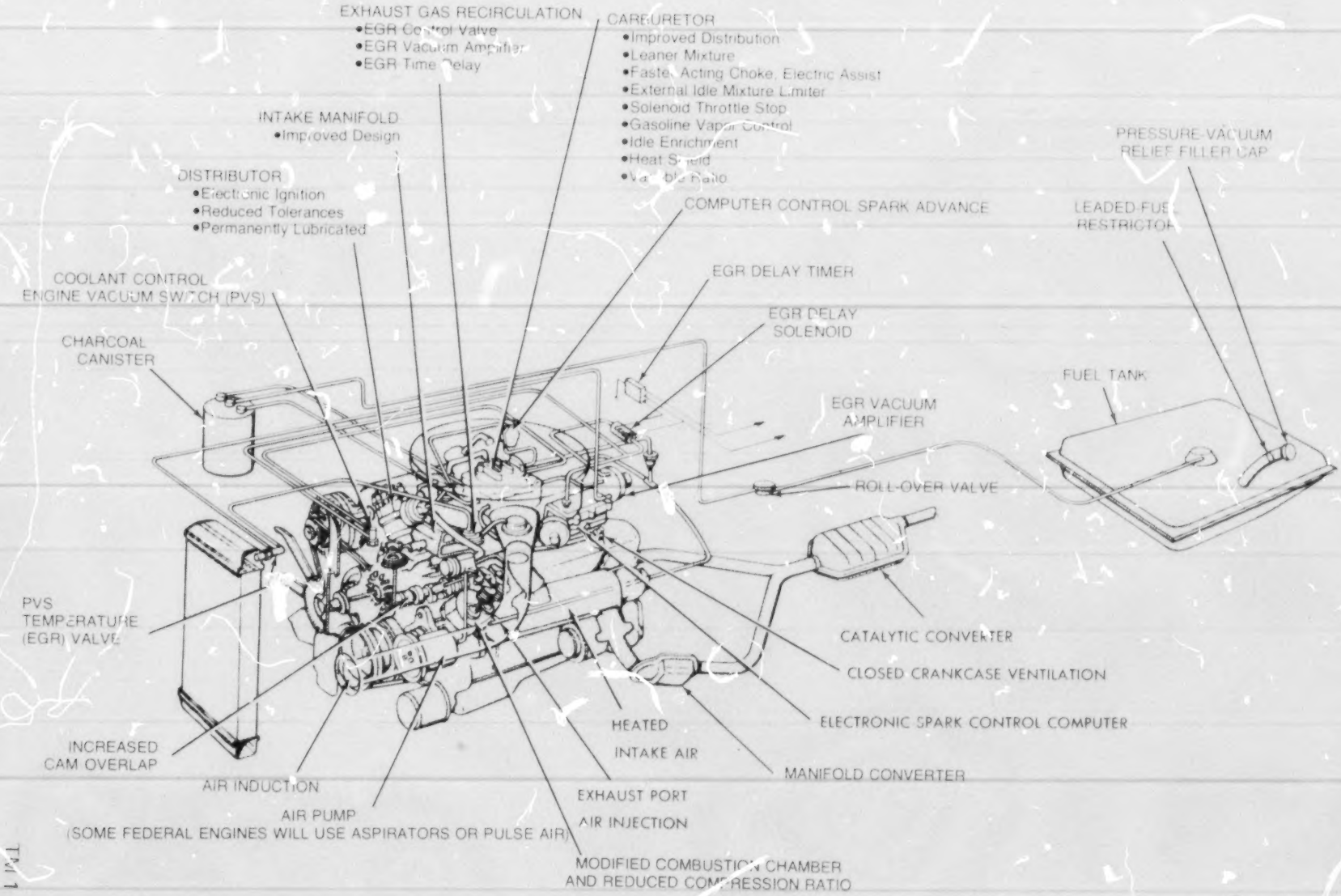
C. Step 3 -- Connect vacuum hose to advance connection and note increase in advance in degrees at fast idle

D. Step 4 -- Connect vacuum hose to retard connection and note drop in advance at normal idle

VI. Purpose for using the idle enrichment method of testing emission control systems-- The idle enrichment method is used to adjust carburetor idle because of factory set idle limiters and precise fuel metering systems built into today's carburetors (Transparency 4)

(NOTE: Specific instructions are provided by vehicle manufacturer. Job Sheet #3 describes the basic procedures.)

Typical Emission Control Components



TM 1

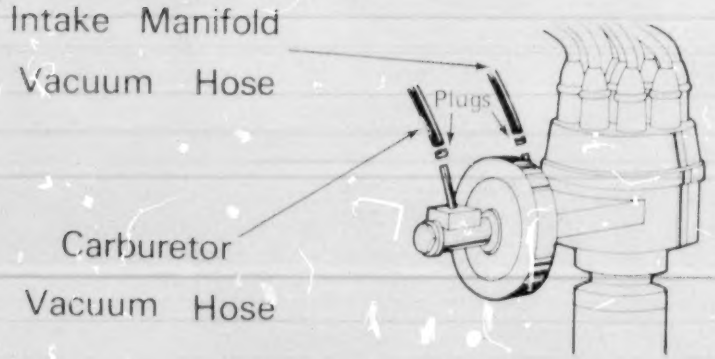
AEC 365

Emission Control System Checklist

1. Check Drive Belt Condition and Tension
2. Check Air Pump Filter
3. Check Condition and Fit of Hoses
4. Check Condition of Fittings to Air Manifold
5. Check Condition of Fittings to Exhaust Manifold
6. Check Operation of Diverter and Check Valves
7. Check PCV Valve
8. Check Ignition Timing
9. Set Engine Idle Speed
10. Check Condition of Catalytic Converter

Typical Check Points

Dual Diaphragm Unit Operation Tests



Step 1.

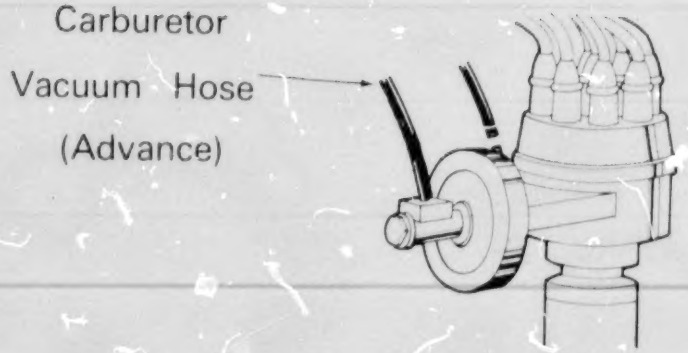
Set Initial

Ignition Timing Step

Step 2.

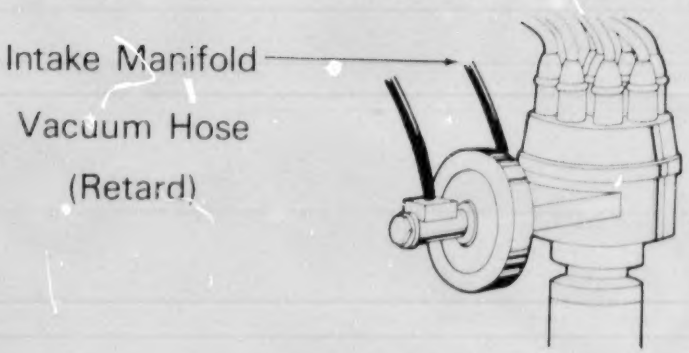
Test Centrifugal

Advance Mechanism



Step 3.

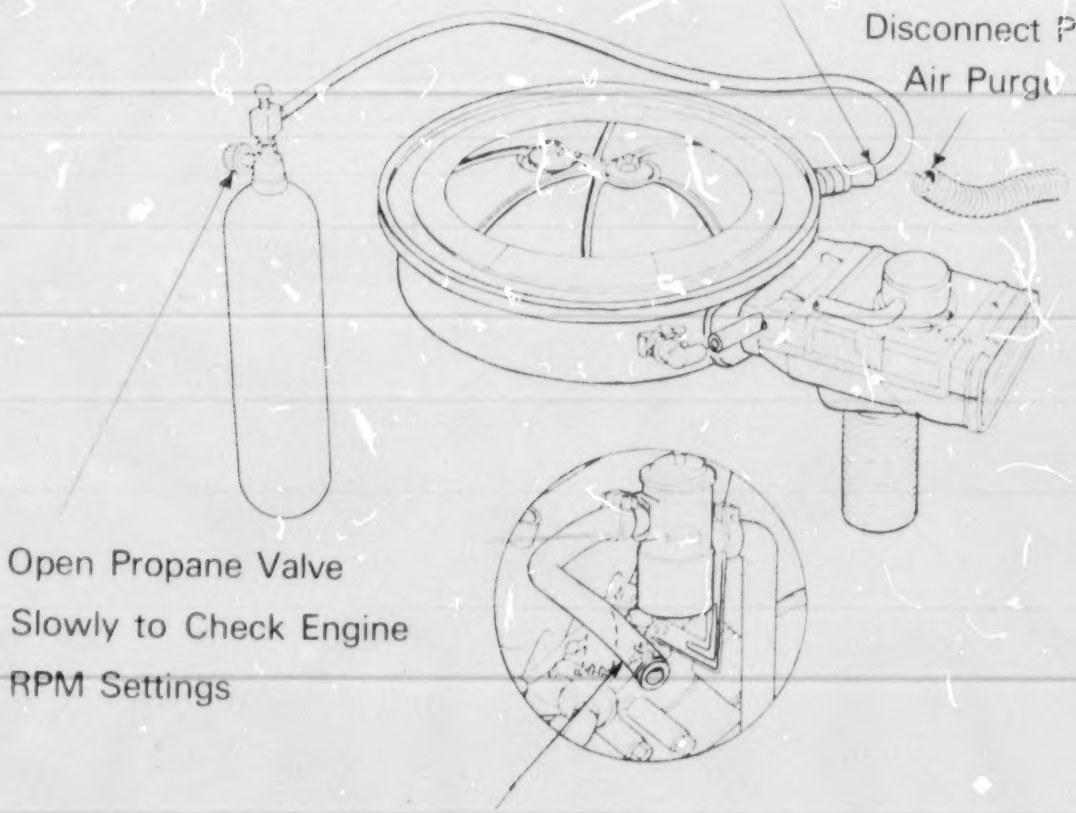
Test Spark Advance



Step 4.

Test Spark Retard

Artificial Enrichment



TESTING
UNIT XVI

JOB SHEET #1 PERFORM A BASIC CHECK OF AUTO EMISSION CONTROL DEVICES

I. Tools and equipment

A. Belt tension tool

B. Timing light

C. Tachometer

D. Basic shop hand tools

II. Procedure:

A. Check general condition of drive belts and check tension using the belt tension tool

(NOTE: If cracked or frayed, replace and adjust tension according to manufacturer's recommendation.)

B. Check passageway and element of air pump filter

(NOTE: Replace if clogged or wash to clean as needed.)

C. Check to see that all hoses are tightly connected to tubes and connectors and that there are no kinks or deterioration present

D. Check air injection fittings and tubing to insure they are tight and clear of obstruction

E. Check air injection connections at exhaust manifold to be certain they are tight

F. Perform basic functional tests for diverter valve operation by interrupting vacuum supply to the valve

G. Disconnect the PCV valve from rocker cover and shaker to determine operational status

H. Replace or reconnect as needed

I. Set ignition timing according to manufacturer's recommendations and procedures

J. Adjust engine idle speed according to manufacturer's recommendation and procedures

JOB SHEET #1

K. Visually inspect catalytic converter to determine corrosion or other damage to assembly and exhaust system

(NOTE: If a component appears to be faulty in the basic check, be certain to perform an indepth test of the system and replace any malfunctioning component. Failure to do so could cause an imbalance on the other components and could lead to serious and costly repairs to the system.)

TESTING
UNIT XVI

JOB SHEET #2 TEST A DUAL DIAPHRAGM VACUUM ADVANCE UNIT FOR PROPER OPERATION

I. Tools and equipment

A. Tachometer

B. Timing light

C. Shop hand tools

D. Hose plugs

II. Procedure:

A. Bring the engine to normal operating temperature

B. Shut off engine and attach timing light and tachometer

C. Start engine and adjust speed to manufacturer's specification

D. Disconnect and plug vacuum hoses to vacuum advance unit

E. Adjust engine rpm as needed and set initial ignition timing to manufacturer's recommendation

F. Accelerate engine to approximately 1500 rpm and note timing advance by centrifugal advance mechanism

(NOTE: If advance is not present remove and inspect distribution mechanism and repair as needed.)

G. Connect vacuum advance hose and increase engine speed to approximately 1500 rpm

H. Note timing advance in degrees at idle and a fast idle

I. Connect retard vacuum hose to distributor unit

J. Note the amount of timing change in degrees

K. If no advance is noted in step H or no retard is noted in step J, replace the vacuum advance unit if vacuum is present at the hose connections

L. If no vacuum is present, check for proper operation of the PVS or for loose or cracked hoses and replace faulty components

M. Stop engine and remove all equipment

(NOTE: Specific settings and test procedures are outlined in the manufacturer's shop manuals.)

TESTING
UNIT XVI

JOB SHEET #3 ADJUST ENGINE IDLE USING THE ARTIFICIAL IDLE ENRICHMENT METHOD

I. Tools and equipment

A. Propane cylinder and attachment tools

B. Tachometer

C. Shop hand tools

D. Hose plugs

II. Procedure

A. Block vehicle rear wheels and set parking brake before starting the engine

B. Make all adjustments with engine fully warmed up, air conditioning off, headlights off, and idle stop solenoid grounded if so equipped

C. Attach a tachometer to the engine

(NOTE: Make certain the tachometer is rated for high energy ignition system.)

D. Disconnect cannister purge hose from air cleaner and plug the connector on air cleaner

(NOTE: Each manufacturer recommends a specific procedure on disconnecting and plugging or leaving hoses and connectors unplugged. Follow manufacturer's recommendation to make certain idle conditions are functional.)

E. Remove PCV hose assembly from air cleaner and plug the opening

F. Allow PCV to draw engine compartment air

(NOTE: It may be necessary to remove air cleaner assembly to perform certain idle adjustments but it must be replaced each time to adjust carburetor idle to specifications.)

G. Adjust curb idle speed to manufacturers recommendations

(NOTE: On vehicles equipped with electronic spark control it is necessary to allow the engine to run at fast idle for a few seconds then wait for approximately one minute while engine is at curb idle before performing the adjustments.)

JOB SHEET #3

H. Disconnect and plug air injection supply lines if engine is so equipped

I. Connect propane adapter hose to the air purge hose so that propane will be drawn into carburetor port nipple (Figures 1 and 2)

(NOTE: Some manufacturers prefer to connect the propane attachment to the air cleaner assembly using the air purge hose inlet connector.)

FIGURE 1

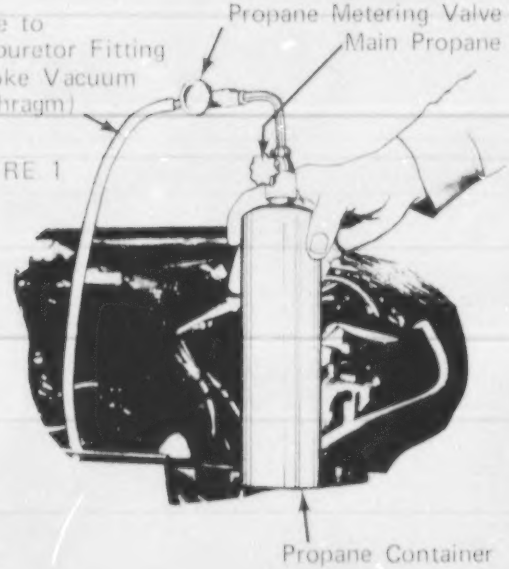
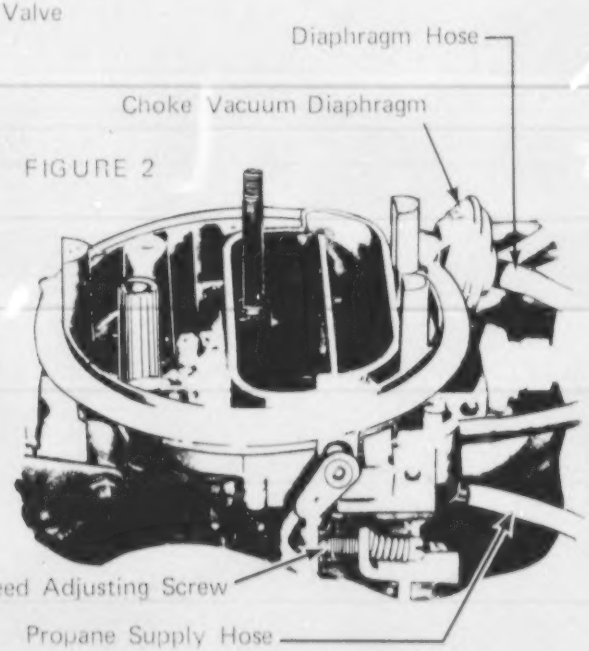


FIGURE 2



J. Slowly open the propane supply valve and observe the engine speed increase

K. Continue to increase propane supply until maximum engine rpm is reached

(NOTE: Engine speed will begin to increase as propane is added but will decrease when too much propane is provided. Adjust propane flow until maximum rpm is maintained. Be certain to keep the propane bottle vertical to ensure constant flow.)

L. With propane on, adjust idle speed screw to manufacturer's specifications for enriched rpm

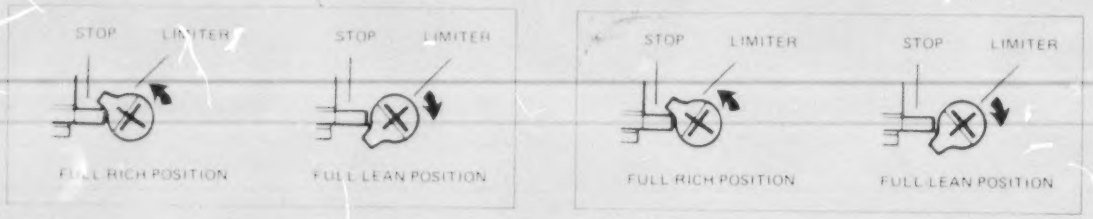
M. Readjust propane flow if needed but do not change once proper enriched speed is set

JOB SHEET #3

N. Adjust idle mixture screws for smoothest curb idle with propane turned off

(NOTE: Curb idle should be at manufacturer's specifications shown on Emissions Control Decal. It may be necessary to remove idle mixture limiter to adjust proper idle. If removed they must be replaced with the tab against the maximum rich stop. Soaking the caps in hot water allows for easier replacement. See Figure 3.)

FIGURE 3



O. After the curb idle has been adjusted for smooth operation, turn propane flow on to determine if idle speed has been affected

P. If idle speed has changed to 25 rpm different from previous setting, repeat steps I through L

Q. Turn off propane supply and stop engine

R. Remove all equipment and reconnect all hoses for normal operation

(NOTE: Engine rpm may increase after connecting all hoses but do not readjust. Vehicle is now set to meet federal requirements. A system check using an infrared engine analyzer will verify emissions levels. Since the analyzers are different, follow manufacturer's instructions on proper use.)

TESTING
UNIT XVI

NAME _____

TEST

1. State the purpose for testing the auto emission control system.

2. Match the pollutants on the right to the appropriate emission control devices by placing the correct abbreviations in the blank beside the following devices.

FUNCTION

_____a. Carburetor calibration

_____b. Air injection or pulse air

_____c. Spark advance controls

_____d. Electric choke assist

_____e. Heated air induction

_____f. Distributor design and calibration

_____g. Positive crankcase ventilation (PCV)

_____h. Initial engine timing

_____i. Exhaust gas recirculation (EGR)

_____j. Catalytic converter (conventional)

_____k. Evaporation control system (gas cap, purge cannister)

_____l. Catalytic converter (Three way)

1. HC
2. CO
3. NO_x

3. State two general rules for testing which apply to all spark advance control devices.

a.

b.

4. Select items which are included on a basic checklist for testing the normal operation of emission control systems by placing an "X" in the appropriate blanks.

   _____a. Set engine idle speed

   _____b. Check PCV valve

   _____c. Check condition of fittings to air manifold

   _____d. Check condition of crankshaft

   _____e. Check air pump filter

   _____f. Check ignition timing

   _____g. Check operation of exhaust valves

   _____h. Check drive belt condition and tension

5. List four steps which are included in the dual diaphragm vacuum advance unit test.

   a.

   b.

   c.

   d.

6. State the purpose for using the idle enrichment method of testing emission control systems

7. Demonstrate the ability to:

   a. Perform a basic check of emission control devices by using a checklist.

   b. Test a dual diaphragm vacuum advance unit for proper operation.

   c. Adjust the idle of an engine using the artificial idle enrichment method.

   (NOTE: If these activities have not been accomplished prior to the test, ask your instructor when they should be completed.)

TESTING
UNIT XVI

ANSWERS TO TEST

1. The purpose of testing the auto emission control system is to establish the most efficient operational setting for maximum engine performance and lowest exhaust gas emission level

2.

a.	HC, CO	g.	HC
b.	HC, CO	h.	HC, CO, NO_x
c.	HC, NO_x	i.	NO_x
d.	HC, CO	j.	HC, CO
e.	HC	k.	HC
f.	HC, CO	l.	HC, CO, NO_x

3. a. If any system does not provide vacuum advance when the engine is either cold or overheated, a temperature control unit is malfunctioning

   b. If any system provides vacuum advance either at idle or when the transmission is in the lower gears, or does not provide vacuum advance when the transmission is in high gear, a speed control device, solenoid, or control module is malfunctioning

4. a, b, c, e, f, h

5. a. Set initial timing to manufacturer's specifications after removing and plugging both vacuum hoses to the advance and retard connections

   b. Test centrifugal advance by accelerating the engine and noting advance on timing marks

   c. Connect vacuum hose to advance connection and note increase in advance in degrees at fast idle

   d. Connect vacuum hose to retard connection and note drop in advance at normal idle

6. The idle enrichment method is used to adjust carburetor idle because of factory set idle limiters and precise fuel metering systems built into today's carburetors

7. Performance skills evaluated to the satisfaction of instructor